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The Ecological Effects of Coal Strip-Mining: A Bibliography With Abstracts

Colorado State Univ, Fort Collins Natural Resource Ecology Lab

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Fish and Wildlife Service, Fort Collins Colo Western Energy and Land Use Team

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THE ECOLOGICAL EFFECTS OF COAL STRIP-MINING: A Bibliography With Abstracts

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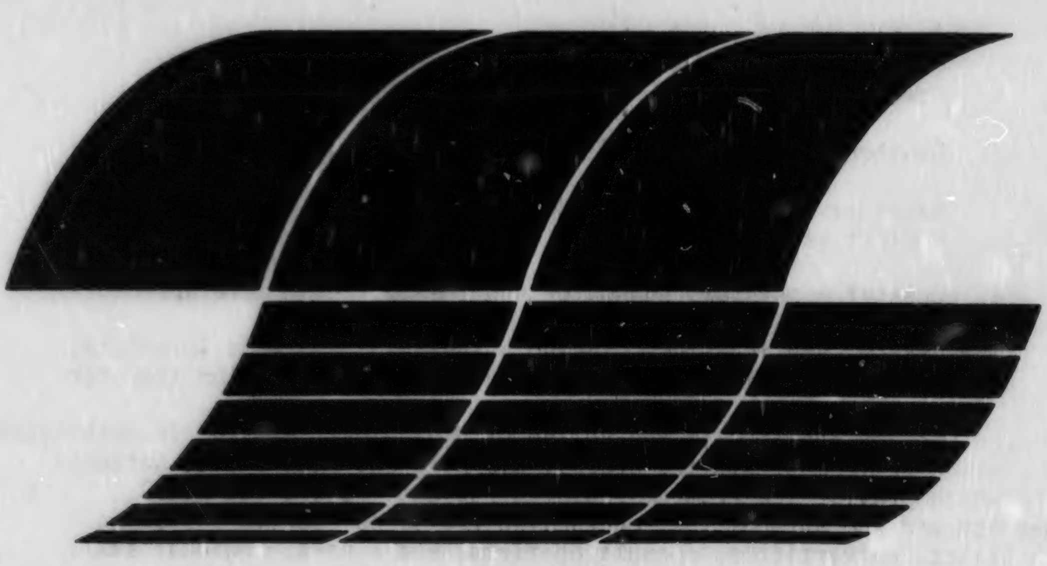

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1. To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.

2. To gather, analyze, and present information that will aid decision makers in the identification and resolution of problems associated with major land and water use changes.

3. To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

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- Water resource analysis, including stream alterations and western water allocation
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This bibliography contains references with abstracts, on the ecological effects of coal strip-mining in the western United States, with particular emphasis on the Northern Great Plains. It does not represent an exhaustive search of all possible literature, but its broad scope will make it useful to workers engaged in strip-mine rehabilitation. There are two parts to this bibliography; part I contains the references and abstracts, part II is an extensive "Keyword in Title" index to the references.

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DISCLAIMER

The opinions, findings, conclusions, or recommendations expressed in this report/product are those of the authors and do not necessarily reflect the views of the Office of Biological Services, Fish and Wildlife Service, U.S. Department of the Interior, nor does mention of trade names or commercial products constitute endorsement or recommendation for use by the Federal Government.

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INTRODUCTION
PART I

This bibliography was prepared under WELUT contract No. 14-16-0008-2107, "A Simulation Approach to the Analysis of Strip-Mining Impact on the Ecosystem with Emphasis on Wildlife". Its primary purposes are to provide an information base (1) for the contractors who are engaged in developing a generalized simulation model of the physical and biological aspects of the rehabilitation process in northern Great Plains ecosystems, and (2) for others who are interested in a comprehensive simulation approach to the rehabilitation of strip-mined lands. For these purposes three general classes of references are included: First, those describing processes and phenomena important in a reclamation context which provide information useful in model building. Second, those describing reclamation problems and management approaches useful during model exercise and experimentation. Third, those describing baseline or undisturbed systems and general plant and animal ecology papers which could provide information useful in interpreting simulation results. It is felt that, although this bibliography is selective and not exhaustive, its broad scope will make it useful to a variety of workers including those engaged in the planning of mining operations, in the regulation of mining activities, and in reclamation research and management.

Geographically, the bibliography concentrates on the western United States, with particular emphasis on the Northern Great Plains. We have, however, included references reporting on work in other areas when it appeared that the topic was of sufficiently general applicability to be of interest to western workers.

The bibliography was generated from a variety of sources. Existing bibliographies relating to strip-mining and reclamation were searched first. *Biological Abstracts* for 1976 was searched for recent background or baseline references. Both of these were then backed up by a conventional search of the open scientific literature. To insure that the bibliography was as current as possible, two computer accessible data bases were searched in November 1976 for references relating to strip-mining. These were BIOSIS (a data base of literature covered in *Biological Abstracts*) and NTIS (a data base developed by the National Technical Information Service, covering Federal government reports and documents).

Abstracts, when they appear, have been derived from numerous sources. Many have been taken from previous bibliographies, both published and unpublished. Some are the author's abstracts and some have been written by us. Every effort has been made to provide a proper acknowledgement for each abstract in the bibliography although it was not always possible to recognize the exact source of an abstract. Any errors or oversights which might exist in this regard are inadvertent and we apologize for them.

Part I of this bibliography contains the complete references and abstracts, where available, organized by subject matter (See Table of

Contents for subject matter organization). Each reference has been assigned a three part number describing its subject matter category (1-12), its subcategory if such exists (A-G) and its numerical sequence within the subcategory (alphabetically by senior author). If a reference is included in more than one subject matter category, its first appearance is the master reference and includes the abstract if available. Second and subsequent appearances are identified by an asterisk (*) prefix and include a cross reference to the master reference. References which include an abstract carry an "A" suffix on the reference number.

Part II of the bibliography is a SWIT (S̲ignificant W̲ord I̲n T̲itle) index to the references. This is an alphabetized, permuted title index, prepared by Ms. Vicki Keith of the Natural Resource Ecology Laboratory. Its use is explained in the Introduction to Part II. This index provides an alternative to the basic subject matter organization for entering the bibliography.

I. CLIMATE AND TOPOGRAPHY

A. Effect of Climate on Spoils and Vegetation

1A-1-A Anonymous. 1970. Reclamation under semiarid conditions. Coal Mining Process. 7(11):34-37.

This article discusses the problems of revegetation in Wyoming. Low sulfur coal keeps acid from forming but low precipitation makes revegetation difficult. Stocking of lakes with fish is also discussed.
(Abstracted by Sally Ralston).

1A-2 Barkley, D. G., R. E. Blazer, and R. E. Schmidt. 1965. Effect of mulches on microclimate and turf establishment. Agron. J. 57:189-192.

1A-3-A Bramble, W. C., H. H. Chrisman, and G. H. Dietschman. 1948. Research on reforestation of spoil banks in Pennsylvania. Pennsylvania State For. School Res. Pap. No. 10. Pennsylvania State Univ., University Park. 6 p.

The authors stress the need for good initial stock and planting techniques. Average survival of all species on banks of pH less than 4.0 was less than 60%. At the end of the first year was very poor for Banks and white pine, black locust, jap larch, but was considered adequate for red and pitch pines, red oak, and black walnut. At the end of the second year there was low survival for all species. Weather was considered the critical factor. In alder plantations, red and Banks pine and Japanese larch grow on banks of pH 3.5-5.0 and Scots, pitch table mountain, and Virginia pines grow on acid banks. Very acid banks should be allowed to weather before planting.
(Abstracted by Sally Ralston).

1A-4-A Brant, R. A. 1964. Geological description and effects of strip mining on coal overburden material. Ohio J. Sci. 64(2):68-75.

Weathering of coal bearing rocks oxidizes pyrites. This releases large quantities of soluble ions at high rates, making the wastes acidic.
(Abstracted by Sally Ralston).

1A-5-A Brezina, E. R., R. S. Campbell, and J. R. Whitley. 1970. Effects of acid mine drainage on water quality of a reservoir. J. Water Pollut. Control Fed. 42(8):1429-1436.

This is a 15-month study of water quality in mine drainage in Montrose Reservoir and tributary Deepwater Creek. It was demonstrated that acid water pollution altered the water quality of Montrose Reservoir. The authors found differences in specific conductants, sulphate ion concentration and bicarbonate alkalinity between the runoff water and reservoir water. The relationship of time of acid inflow to rainfall was established. The major change in creek water quality occurred within 1.5 hours of the onset of rain.
(Abstracted by Sally Ralston).

1A-6-A Chapman, A. G. 1967. How strip land grading affects tree survival and growth. School Agric. Publ. No. 29, Southern Illinois Univ., Carbondale. 43 p.

At this time the foremost problems confronting the planner of reclamation of surface mined land is unquestionably the compaction of plastic clay spoil by overgrading. Emphasis is placed upon the highly variable chemical and physical characteristics of the soil fraction, the conditions resulting through compaction and the effects of these conditions upon the survival and growth. Compaction destroys soil porosity, thereby creating poor conditions for air and water movement, plant nutrient availability, and thrift of soil flora fauna. But sands, sandy loams and sandy clay loams with less than 15% clay, all in the minority among soil classes in spoil, and spoil with much coarse rock in the surface material were not appreciably affected directly by grading. Both erosion and water runoff may be lessened by avoiding long, smooth, compacted slopes. Because of the extreme variability of the spoil areas, no single prescription may be offered for effective vegetation of all mined areas. Finally, this is intended primarily for those who are interested and have a part in planning and developing procedures for the reclamation of surface mined land with trees for the highest net return.
(Abstracted by author).

1A-7-A Curtis, W. R. 1971. Strip-mining, erosion and sedimentation. Trans. ASAE 14(3):434-436.

Spoil banks are heterogenous mixtures of sandstone, limestone, shale, and soil. There is no developed soil zone and very sparse vegetation. Weathering and erosion begin on the spoilbank as soon as the mining operation exposes the unconsolidated and unprotected material. The rate of weathering is faster in this freshly exposed material than in unmined areas. Generally, larger storms produced more sediment, but the maximum concentrations of sediment also depend on the area disturbed and whether mining is active.

(From author's summary).

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R71-8, p. 56).

1A-8-A Darmer, G. 1967. Wind-tunnel experiments on structure and arrangement of shelter plantations in the region of slopes on waste tips and dumps. Boitr. Landespflege 3(2):102-124.

New procedures (colmation) make possible the creation of agricultural acreage on the heaps of lignite opencast mining. Within the exposed high areas, agriculture is subject to modified location conditions; for example, the wind velocity between 3 and 100 m/sec overground increased by approximately 4-5 m/sec. Slopes and surface of the dumps are to be protected against the injurious conseqences of the strong action of the wind. In addition to the problem, afforestation in the region of the slopes has additional importance. Using models of six different forms of slopes with various composition of plants, suitable investigations were carried out under uniform wind conditions of 7 m/sec, in the wind tunnel.

The tests without setting plants show definitely the heavy exposure of the pominent edges, especially in the highest slope edge. More gentle slopes will have a more favorable effect.

(From author's abstract).

1A-9 Ellison, W. D. 1950. Soil erosion by rainstorms. Science 11:245-249.

1A-10-A Harrington, T. A. 1960. Frost heaving ruins spoil bank seeding. Southern For. Notes, Southern For. Exp. Sta. No. 128(3), For. Abstr. 23(1962):3727.

After initially successful direct sowing of shortleaf pine on 1-year old spoil banks from coal strip mining in Tennessee, alternate freezing and thawing of the exposed soil worked 94% of the seedlings out of the ground. It is thought that older banks may be less susceptible.

(Abstracted by Sally Ralston).

1A-11-A Hill, L. W. 1960. How precipitation affects strip-mined pond water levels in southeast Ohio. USDA Central States For. Exp. Sta., Columbus, Ohio. 2 p.

The pond level rise for various amounts of rainfall is described.
(Abstracted by Sally Ralston).

1A-12 Hinds, W. T. 1969. Elevational alteration of temperature/precipitation relations in a semi-arid shrub steppe: A preliminary survey. Northwest Sci. Assoc. Rep. No. BNWL-SA-2402. Richland, Washington.

1A-13 Hursh, C. R. 1949. Climatic factors controlling roadside design and development, p. 9-19. *In* Report of Committee on Roadside Developments, presented at the 28th Meeting of Highway Research Board.

1A-14-A Lang, R. 1971. Reclamation of strip mine spoil banks in Wyoming. Agric. Exp. Sta. Res. J. 51 (September). Univ. Wyoming, Laramie. 32 p.

A report compiled from three theses. Early spring was found to be the best time to plant and the most limiting factor was the amount of moisture received during and after planting.
(Abstracted by Sally Ralston).

1A-15-A Lowry, G. L. 1961. Some physico-chemical characteristics of weathering coal spoils and their influence on the growth of pine seedlings. Ph.D. Diss. Michigan State Univ., Ann Arbor. Also in Diss. Abstr. 22:1774-1775.

Nineteen coal spoils were examined. Soils of pH 2.1-2.8 were associated with the deepest weathering; soils of pH 7.5 or more were the least weathered after 21 months. Samples weathered the most lost most water by evaporation and suffered the least leaching; surface bulk densities were least but surface runoff greatest in the deeply weathered spoils. Total soluble salt concentrations in the leachate were greatest in the very acid soils. Significant quantities of toxic ions only occurred where pH was below 3.0. Mortality of *Pinus strobus* seedlings was associated with presence of Fe and Al in the soil solution. All seedlings growing on spoils were deficient in N only. The spoils generally contained much silt and clay; illite and kaolinite were prominent in the clay. Nature of the clay minerals was not associated with seedling growth.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 48).

1A-16-A Lowry, G. L., and J. H. Finney. 1962. A lysimeter for studying the physical and chemical changes in weathering coal spoils. Ohio Agric. Exp. Sta. Circ. No. 113. Wooster, Ohio. 17 p.

This article describes a project to measure volume and weight loss of spoil samples exposed to the weather. Lysimeters (plastic cylinders) were filled with a definite volume of spoil material. Perforated base allows leachate to escape. Nineteen spoil samples were used in addition to a silt loam.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R62-8, p. 18.).

1A-17-A Richardson, J. A. 1958. The effect of temperature on the growth of plants on pit heaps. J. Ecol. 46(3):537-546.

Because of the composition and the slope of pit heaps, high temperature may persist in the surface layer for several hours daily in the summer. Temperature records are given which show the ameliorating effect of the presence of colonizing species such as *Agrostis tenuis* and *Holcus mollis*. The rate at which pioneering species became established on the pit heaps appears to be accelerated by the presence of a moss/lichen layer.

(From Herbage Abstr. 29).

1A-18-A Schramm, J. R. 1966. Plant colonization studies on black wastes from anthracite mining in Pennsylvania. Trans. Am. Philos. Soc. 56(1):194.

An extensive work on factors that influence the establishment of vegetation on mining waste, especially spoil banks and sludge setting basins in the Pennsylvania anthracite region. Topics discussed include the effect of moisture, wind, frost, and pH of spoil on the establishment of vegetation; the physiological effects of high temperature on plants; the effect of physical properties and position of wastes on temperature gradients; and the role of root symbiosis on the plant growth.

(From British bibliography, unpubl., p. 51).

1A-19-A Struthers, P. H. 1964. Chemical weathering of strip-mine spoils. Ohio J. Sci. 62(2):125-131.

Amounts of salts leached from strip mine spoils were determined in lysimeter studies. Among the observations are: weathering improves toxicity; and soluble mineral plant nutrients were generally more abundant in spoils than in Ohio soils.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R64-34, p. 29).

1A-20 Struthers, P. H. 1965. Rapid spoil weathering and soil genesis. Presented at Coal Mine Spoil Reclamation Symposium. (October), School For., Coll. Agric., Pennsylvania State Univ., University Park.

1A-21 Vimmerstedt, J. P., and P. H. Struthers. 1968. Influences of time and precipitation on chemical composition of spoil drainage, p. 152-163. *In* 2nd Symp. on Coal Mine Drainage Research, Pittsburgh, Pa. Ohio River Valley Sanitation Commission, Cincinnati, Ohio.

1A-22 Weigle, W. K. 1965. Road erosion and spoil bank stability. Presented at Coal Mine Spoil Reclamation Symposium. (October), School For., Coll. Agric., Pennsylvania State Univ., University Park.

1A-23 Wischmeier, W. H., and D. D. Smith. 1965. Predicting rainfall-erosion losses from cropland east of the Rocky Mountains. Agric. Handb. No. 282. USDA Agric. Res. Serv., Washington, D.C. 47 p.

B. Ecological Impact and Management of Topographic Features

1B-1-A Bridges, E. M. 1961. Aspect and time in soil formation. Agriculture (London) 68:358-363.

Soil formation has been studied on, and between the overburden in the ironstone mining area of Northhamptonshire. The overburden forms a series of parallel heaps, and it and the land between the heaps forms the so-called "hill and dale." Most of the hill and dale has been planted with larch and other trees. At present, aspect is as important as time in soil formation. On the hills, imperfectly to freely drained calcareous soils are developing on south-facing slopes, but in the dales gleying is occurring. Soil formation has been slight on north-facing slopes.

(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 41).

1B-2-A Brown, J. H., and E. H. Tyron. 1960. The establishment of seeded black locust on spoil banks. Agric. Exp. Sta. Bull. No. 440. West Virginia Univ., Morgantown. 34 p.

Success in revegetating spoil banks by seeding with black locust seemed to depend on soil pH, time of seeding, amount of precipitation, and steepness of slope.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R60-1, p. 13).

1B-3-A Coates, W. E. 1973. Landscape architectural approach to surface mining reclamation, p. 26-41. *In* First Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

In view of the landscape architect, strip mining should be considered as an interim land use and provision must be made to return mined-land to the highest and best use compatible with use of adjoining land. Advantages claimed for planning rehabilitation as part of the mining operation are low cost, reducing overburden handling and equipment movement, and minimal open raw areas at any time during the mining operation. The most immediate needs for vegetative cover, preventing erosion and improving the soil, can be met best by legumes and grasses. Therefore, the author suggests the use of trees only for screening exposed highwall, for visual accents, or as sources of seed for volunteer seedlings where there are no nearby mature forests.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-37, p. 85).

1B-4-A Corner, J. T. 1968. Waste tip stabilization in the Ruhr Colliery. Colliery Guardian 1968:250-253.

In the Ruhr, tipping is planned and vegetation is used for stabilization. The tips are built up on a terrace system. This allows cultivation of the outside slopes from the beginning, making the tips less unsightly. The resulting structure is stable because of its terraces. (From British bibliography, unpubl., p. 22).

1B-5-A Curtis, W. R. 1971. Terraces reduce runoff and erosion on surface-mine benches. J. Soil Water Conserv. 26(5): 198-199.

A two-year study in Breathitt, Kentucky indicated that terraces can effectively control runoff and erosion on surface-mine benches. In an area where the spoil was predominantly shale, peak flows on a terraced plot averaged 65 percent less than on a control plot, sediment yield averaged 52 percent less, and total runoff averaged 42 percent less. Comparable figures on a set of plots having substantial amounts of sandstone were 65, 70, and 6 percent respectively. Average storm runoff duration was 1 percent higher on the terraced plot of each pair. (Abstraced by author). (From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R71-9, p. 56).

1B-6-A Curtis, W. R. 1973. Moisture and density relations on graded strip-mine spoils, p. 135-144. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 1. Gordon and Breach, New York, N.Y.

This paper reports the first-year results of a study to determine the disposition of subsurface moisture on leveled spoil banks in western Kentucky and to determine whether the moisture conditions can be changed through scarification and vegetative treatments. (Abstracted by author). (From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-44, p. 87).

1B-7* Darmer, G. 1967. Wind-tunnel experiments on structure and arrangement of shelter plantations in the region of slopes on waste tips and dumps. (See 1A-8-A).

1B-8 Deasy, G. F., and P. R. Griess. 1959. Coal strip pits in the northern Appalachian landscape. J. Geogr. 58(2):72-81.

1B-9 Dix, R. L. 1958. Some slope-plant relationships of the Little Missouri Badlands of North Dakota. J. Range Manage. 11:88-92.

1B-10 Doerr, A. H. 1961. Coal mining and landscape modifications in Oklahoma, p. 21-33. *In* Okla. Geol. Surv. Circ. No. 54, Univ. Oklahoma, Norman.

1B-11-A Graham, M. 1959. Erosion and the revegetation of spoil heaps: Some field trials. Community Council of Lancashire, England. 22 p. (Typescript).

The tests show that surface instability prevented vegetation of spoil heaps. Grass was established successfully at 12 plots at different sites in Lancashire by contour ridging, sowing "vigorous" grasses, pegging with sallow cuttings and the addition of organic matter and lime.

(From British bibliography, unpubl., p. 20).

1B-12-A Jensen, I. B., and R. L. Hodder. 1975. Effects of surface configuration in water pollution control on semiarid surface mined lands, p. 325-335. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 3. Eastern Montana Coll., Billings.

Two investigations are described in detail. The first involved a study of three techniques to trap precipitation on mined spoils, thus preventing erosion and moisture loss. The techniques were: (1) gouging, (2) dozer basins, and (3) deep chiseling. The experimental areas were compared as to their vegetative cover and the number of days their moisture content fell below the plant wilting point at various levels. Gouging proved to be the most effective technique according to the preliminary study.

Further investigation of five surface manipulations is then described as being in progress at this time. Evaluation of treatment efficiency includes consideration of the efficiency of application over large areas, rates of surface runoff and erosion, quality of surface runoff, infiltration and percolation rates for water stored in surface depressions, chemical quality of water percolating through spoils, quantitative evaluations of the hydrologic cycle of the spoils, changes in quantity and quality of water in the underlying aquifers, and the monitoring of underlying areas for potential new aquifer development. All the techniques employed are described in detail.

(Abstracted by Sally Ralston).

1B-13 Kaul, R. N., A. Cherian, and H. S. Daulory. 1966. Microrelief as a decisive factor in the development of vegetation in arid zones. La-Yaaran (India) 16:122-128, 164-170.

1B-14 Limstrom, G. A. 1952. Effects of grading strip mined lands on the early survival and growth of planted trees. Central States For. Exp. Sta. Tech. Pap. No. 130. U.S. Forest Serv. (Columbus, Ohio).

1B-15 Limstrom, G. A. 1967. How stripland grading affects survival and growth. School Agric. Publ. No. 29. Southern Illinois Univ., Carbondale.

1B-16-A Lorio, P. L., Jr. 1963. Tree survival and growth in Iowa coal spoil material. Diss. Abstr. 23:3583-3584.

Survival and height values are reported for 13 species planted on coal spoils in five counties in southwestern Iowa. These are related to physical and chemical properties of the soil and position of the trees on the slope.

(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 20).

1B-17-A May, R. H. 1964. Predicting outslopes of spoil banks. Mining Congr. J. 50(4):104-105.

"... How much of downslope strip mined area will be covered by spoil material ..."

(From R. K. Honkala. 1974 bibliography).

1B-18 Rickard, W. H., W. T. Hinds, and R. O. Gilbert. 1971. Environmental and biologic observations on contrasting slopes of small earth mounds. Northwest Sci. 45(1):7-18.

1B-19-A Riley, C. V. 1973. Design criteria of mined land reclamation. Mining Eng. 25(3):41-44.

Criteria essential to insuring successful mined land reclamation must include a knowledge and appreciation of the significance of the geochemistry of the overburden, spoil placement grading for proper topography and spoil surface, all relative to improved site conditions necessary for the successful establishment of vegetation, spoil stabilization, erosion control and water management.

(From text).

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-123, p. 103).

1B-20 Roberts, J. R. 1971. Grading and slopes used in reclamation, p. 51-53. *In* Symposium on rehabilitation of drastically disturbed surface mined lands. Georgia Surface Mined Land Use Board, Macon, Ga., 4-5 Nov.

1B-21 Schumm, S. A. 1961. Effect of sediment characteristics on erosion and deposition in ephemeral stream channels. Progress Pap. 352-C. U.S. Geol. Surv., USDI, Washington, D.C.

1B-22-A Struthers, P. H., and J. P. Vimmerstedt. 1965. Advances in stripmine reclamation. Ohio Rep. Res. Development 50(1): 3-5.

This short paper recommends terracing or grading spoil areas to control erosion. Planting of both trees and grasses, rather than either of them alone is also recommended as a means of erosion control and revegetation. Orchard grass with a species of legume to provide the lacking nitrogen in recommended for the initial establishment of vegetation. Empire birdsfoot trefoil and Kentucky bluegrass are highly recommended as follow-up grasses as they eventually give the best cover known for soil formation, despite being slower to become established. (Abstracted by Sally Ralston).

1B-23 United States Department of Interior. 1970. A systematic analysis of pit slope structures by the stiffness matrix method. Rep. of Investigations No. 7343. Bur. Mines, USDI, Washington, D.C. 37 p.

1B-24 Williams, G. P. 1967. Roads, slides, and check dams. *In* Stripmining Symp., Owensboro, Kentucky. (July 13-14). Sponsored by Dep. Nat. Resources, Div. Reclamations, Frankfort, Ky. 103 p.

1B-25-A Williams, G. P., Jr. 1973. Changed spoil dump shape increases stability on contour strip mines, p. 243-249. *In* First Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

A survey of mines operating under Kentucky's 1966 regulations revealed that approximately 94 percent of the outslopes were stable. Of the 178 slides which occurred, nearly half involved spoils dumped in valleys. Slides occurred over the entire range of slopes; slide incidence and terrain steepness were not found to be related. Increased storage of spoil upon the excavated bench accounted for a 42 percent reduction in area disturbed by slides and a 17 percent reduction in total areal disturbance. The overall level of instability on spoil dump outslopes is still excessive, but this instability can be reduced as knowledge of the physical and mechanical properties of spoils and of site characteristics is accumulated and incorporated into mining and spoil placement techniques.

(From author's abstract).

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-163, p. 112).

C. Erosion Potentials, Causes, and Prevention

1C-1 Armbrust, D. V., and J. D. Dickerson. 1971. Temporary wind erosion control: Cost and effectiveness of 34 commercial materials. J. Soil Water Conserv. 26:154-157.

1C-2 Astrup, M. H. 1955. Erosion control on extremely sandy soils, p. 3-13. *In* Rep. Comm. on Roadside Develop. Publ. No. 356. Highway Res. Board.

1C-3 Booth, W. E. 1941. Algae as pioneers in plant succession and their importance in erosion controls. Ecology 22(1):38-46.

1C-4-A Breeding, C. H. J. 1961. Crown vetch as an aid to strip mine reclamation. Mining Congr. J. 47(4):70-71.

Coronilla varia improved soil structure and increased nitrogen accumulation. Plants formed a dense cover preventing soil erosion. Best development was on alkali soils. Combined sowing of crown vetch with grasses and legumes was highly effective.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 40).

1C-5* Curtis, W. R. 1971. Strip-mining, erosion and sedimentation. (See 1A-7-A).

1C-6-A Curtis, W. R. 1972. Strip-mining increases flood potential of mountain watersheds, p. 357-360. *In* National Symposium on Watersheds in Transition, Ser. 14. Am. Water Resources Assoc. and Colorado State Univ., Fort Collins.

A study in eastern Kentucky indicated that surface mining for coal alters the natural processes and affects the water resources in small Appalachian watersheds. Peak flow rates increased by a factor of 3 to 5 after surface mining. Lag time was reduced, thus affecting an increase in the rate at which flood peaks move downstream. It appears that peak flow is directly and positively correlated with the percent of area disturbed during surface mining.
(From author's abstract).
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R72-11, p. 66).

1C-7-A Curtis, W. R. 1974. Sediment yield from strip-mined watersheds in eastern Kentucky, p. 88-100. *In* Second Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Louisville, Ky.

Measurements of sediment accumulation in debris basins below surface mined lands in eastern Kentucky show

highest sediment yield during the first 6 months after mining. The erosion rate diminishes to a fairly low level within 3 years. Methods of mining and handling spoil affect sediment yield, as does the speed with which vegetative cover is established.
(Abstracted by author).

1C-8 Davies, W. E. 1968. Coal waste bank stability. Mining Congr. J. 54(7):19-24.

1C-9 Ellis, M. M. 1936. Erosion silt as a factor in aquatic environments. Ecology 17:29-42.

1C-10 Environmental Protection Agency. 1971. Control of erosion and sediment deposition from construction of highways and land development. Office of Water Programs, EPA, Washington, D.C. 50 p.

1C-11 Haupt, H. F. 1959. Roadside slope characteristics affecting sediment movement from logging roads. J. For. 57:329-332.

1C-12 Hodder, R. L. 1973. Test pit stabilization and revegetation study. Consolidated Coal Co. Progr. Rep. 1973. Montana Agric. Exp. Sta., Montana State Univ., Bozeman. Res. Rep. No. 57, March 1974. 17 p.

1C-13 James, A. L. 1966. Stabilizing mine dumps with vegetation. Endeavor 25:154-157.

1C-14-A Jeppson, R. W., R. W. Hill, and C. E. Israelson. 1974. Slope stability of overburden spoil dumps from surface phosphate mines in southeast Idaho. Utah Water Resources Lab., Utah State Univ., Logan.

This paper discusses the various tests utilized to determine the engineering properties of dump materials in detail. These tests include those for permeability, direct shear, triaxial properties and the fertility of the soil.

Conclusions regarding stability against mass failure are drawn. Effects of variations in structural properties are discussed. Erosion and hydrology of the two mine sites studied are related to orientation, grain size and the effects of snowmelt.

The appendices include discussions of slope stability and stress analysis; a computer program for analysis of slope stability, a computer program listing for snowmelt simulation at mine dump sites and rehabilitation of surface mined lands with a selected bibliography.
(From author's abstract).

1C-15-A Keys, J. W. III, J. F. Ruff, and M. M. Skinner. 1975. A remote sensing study of sediment in the Clarks Fork, Yellowstone River, p. 156-166. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 2. Eastern Montana Coll., Billings.

A procedure for the location of sediment sources and determination of the relative magnitude of sediment problem being experienced in a basin is described. The application of remote sensing techniques to the determination of sediment sources and magnitude is discussed in detail along with the findings on the Clarks Fork of the Yellowstone River.
(Abstracted by Sally Ralston).

1C-16 May, R. F., and W. D. Striffler. 1967. Watershed aspects of stabilization and restoration of strip mined areas, p. 663-671. *In* W. E. Sopper and H. W. Lull (eds.) Forest hydrology. Proc. NSF Science Seminar at Pennsylvania State Univ., University Park, Pa. Pergamon Press, New York.

1C-17 McClurkin, D. C. 1967. Effects of selected grasses and legumes on soil erosion and recovery rates. U.S. Forest Serv., Southern For. Exp. Sta. 1 p.

1C-18-A McWilliams, J. L. 1969. Arnot bristly locust. Am. Nurseryman 130(1):13.

A description of the Arnot Bristly Locust (*Robinia fertilis* (Ashe)) with recommendation for its use in erosion control. As well as establishing rapidly and providing good cover, it fixes nitrogen, grows on soil of a wide range of pH (4.0-7.5) and is drought tolerant.
(From British bibliography, unpubl., p. 99).

1C-19 Meeuwig, R. D. 1970. Infiltration and soil erosion as influenced by vegetation and soil in northern Utah. J. Range Manage. 23:185-188.

1C-20 Meyer, L. D., W. H. Wischemeier, and W. H. Daniel. 1971. Runoff and revegetation of denuded construction sites. Trans. Am. Soc. Agron. Eng. Gen. Ed. 14(1):138-141.

1C-21-A Moffat, D. J. 1967. A field study into the soil forming factors operating on colliery waste sites. Landscape Reclamation Proj., Dep. Soil Sci., Univ. Newcastle-upon-Tyne.

A survey of soil formation on 26 pit heaps in county Durham and Northumberland showed that: (1) vegetation grows more readily in hollows, decreases erosion, and accumulates material from higher up the slope; (2) scrubland deciduous woodlands give more stability to the slope than conifers; (3) pH varies with topography, ranging

from the lowest at the top to the highest at the bottom of the heap; and (4) red shales have higher pH than black and generally have better ground cover.
(From British bibliography, unpubl., p. 23).

1C-22 Swanson, N. P., A. R. Dedrick, and A. E. Dudek. 1967. Protecting steep fill slopes against water erosion. Agric. Abstr. 1967:55.

1C-23* Weigle, W. K. 1965. Road erosion and spoil bank stability. (See 1A-22).

1C-24-A Weigle, W. K. 1966. Erosion from abandoned coal haul roads. J. Soil Water Conserv. 21(3):92.

The author points out the need for controls of the coal haul road's contribution to stream sedimentation. (Abstracted by Sally Ralston).

D. General Papers Pertinent to Climate and Topography

1D-1 Changnon, S. A. 1968. The Laporte weather anomaly: Fact or fiction? Bull. Am. Meteorol. Soc. 49:4-11.

1D-2 Coupland, R. T. 1958. The effect of fluctuations in weather upon the grasslands of the Great Plains. Bot. Rev. 24:273-317.

1D-3 Deasy, G. F., and P. R. Griess. 1957. Geographical significance of recent changes in mining of the bituminous coal fields in Pennsylvania. Econ. Geogr. 33(4):283-298.

1D-4 Dutt, G. R., R. W. Terkeltour, and R. S. Rauschkolb. 1972. Prediction of gypsum and leaching requirements for sodium-affected soils. Soil Sci. 114(2):93-103.

1D-5-A Fies, J. C. 1972. Textural aspects of soil porosity. Ann. Agron. (Paris) 22(6):655-685.

The relationship between porosity of soils and their texture is discussed in light of theoretical models. Kaolinite and montmorillonite are some clays that are discussed.
(Abstracted by Sally Ralston).

1D-6 Fitzgerald, J. W., and P. A. Spyers-Duran. 1973. Changes in cloud nucleus concentration and droplet size distribution associated with pollution from St. Louis. J. Appl. Meteorol. 12:511-518.

1D-7 Megahan, W. F. 1974. Erosion over time on severely disturbed granitic soils: A model. U.S. Forest Serv. Res. Note INT-156. Intermountain For. Range Exp. Sta., Boise, Idaho. 14 p.

1D-8 Morgenstern, M. R., and V. E. Price. 1965. Analysis of the stability of general slip surfaces. Geotechniques 15:79-93.

1D-9 Schumm, S. A., and R. F. Hadley. 1957. Arroyos and the semiarid cycle of erosion. Am. J. Sci. 255:161-174.

1D-10* Williams, G. P. 1967. Roads, slides, and check dams. (See 1B-24).

1D-11* Wischmeier, W. H., and D. D. Smith. 1965. Predicting rainfall-erosion losses from cropland east of the Rocky Mountains. (See 1A-23).

II. SOILS AND SPOILS

A. Chemical and Physical Characteristics of Coal Strip-Mining Spoils

2A-1-A Alizai, H. U., and L. C. Hulbert. 1970. Effect of soil texture on evaporative loss and available water in semiarid climates. Soil Sci. 110:328-332.

These experiments confirm that more water evaporates from fine-textured than from coarse-textured soils and support the hypothesis that differences in evaporation help explain the more mesophytic vegetation on coarse than on fine-textured soils in semiarid and arid areas. (Abstracted by Sally Ralston).

2A-2 Ashley, G. D., and B. Wilkinson. 1959. Some observations on soil development on restored opencast coal sites. NAAS Quarterly Rev. 10:147-153.

2A-3-A Barnhisel, R. I., and H. F. Massey. 1969. Chemical, mineralogical and physical properties of eastern Kentucky's acid-forming coal spoil materials. Soil Sci. 108(5):367-372.

Analyses of five spoil samples of the area showed that the extreme acidity of the spoil materials and associated levels of Fe, Mn, Cu, and Zn were not conducive to the establishment of cover. It is suggested that potentially harmful acid producing layers should be either buried within the spoil banks or that large amounts of limestone should be added to neutralize the acids.
(From Commonw. Bur. Soils Annot. Bibliogr. 1456. No. 7).

2A-4 Beauchamp, H., R. L. Lang, and M. May. 1975. Topsoil as seed source for reseeding stripmine spoils. Wyoming Agric. Exp. Sta. Res. J. No. 90. Univ. Wyoming, Laramie.

2A-5 Berg, W. A. 1965. Plant-toxic chemicals on acid spoils, p. 91-96. *In* Coal Mine Spoil Reclamation Symposium. School For., Coll. Agric., Pennsylvania State Univ., University Park, Pa.

2A-6 Berg, W. A., and R. F. May. 1969. Acidity and plant available phosphorus in the strata overlying coal seams. Mining Congr. J. 55(3):31-34.

2A-7 Berge, H. 1970. The suitability of clay-slate spoil mounds for afforestation. Agnew. Bot. 43:309-330.

2A-8-A Blenkinsop, S. 1957. Some aspects of the problem of the restoration of opencast coal sites. Planning Outlook 4(3):28-32.

Disturbances of the soil during the extraction of opencast coal destroys the structure, making the soil susceptible to compaction and waterlogging. The soil fauna is usually destroyed during the storage of the overburden, and subsoil may remain on the surface when operations are complete. Careful management is required to restore fertility and prevent poaching or overgrazing by animals.

(From British bibliography, unpubl.).

2A-9-A Bond, J. J., et al. 1973. Lignite mine spoils in the northern Great Plains: Characteristics and potentials for reclamation. *In* First research and applied technology symposium on mined-land reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

Overburden materials left as spoils on the surface after strip-mining for lignite and subbituminous coal in North Dakota, Montana, and Wyoming were studied in the laboratory and in the field to evaluate their potential for reclamation and revegetation. Results show that the physio-chemical properties of materials presently left as spoils provide a very poor environment for vegetative growth. Materials from the Tongue River and Sentinel Butte formations were fine-textured, moderately saline and highly sodic. Other problems include high clay and highly absorbed sodium content, low organic matter and low available phosphorus.

(From Dalsted and Leistritz. 1973 bibliography. No. E-2, p. 16).

(See also Sandoval et al. 6A-52-A).

2A-10* Brant, R. A. 1964. Geological description and effects of strip mining on coal overburden material.

(See 1A-4-A).

2A-11* Bridges, E. M. 1961. Aspect and time in soil formation.

(See 1B-1-A).

2A-12-A Brohard, E. 1962. Strip revegetation. Coal Age 67(3):64-65.

This author explains that soil sourness is the number one problem on stripped areas. The article shows several pictures illustrating various stages of planting and soil preparation. Fertilizer and lime application formulas are included as necessary for extremely acid soil. A sweet strip spoil can be revegetated quite readily. The main objective is to make the right decision so that the land can be developed in the shortest possible time.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R62-3, p. 17).

2A-13 Brooks, R. H., and A. T. Corey. 1966. Properties of porous media affecting fluid flow. J. Irrigation Draininage Div. 92(ER2):61-87. (Paper 4855). Also in 1967. Trans. ASCE 132:304-305.

2A-14-A Carlson, C. G., and W. M. Laird. 1964. Study of spoil banks associated with lignite strip mining in North Dakota: A report prepared for the Thirty-ninth Legislative Assembly. North Dakota Geol. Survey Misc. Ser. 24. Grand Forks, N.D. 28 p.

This study was conducted to determine the extent and condition of spoil piles from previous strip mining operations, to determine current operations and reclamation practices, and to make recommendations for future operations. It was generally agreed that these spoil banks would support plant life but further revegetation research was urged. Wildlife habitat was one of the land uses recommended.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R64-3, p. 24).

2A-15-A Chadwick, M. J., S. M. Cornwell, and M. E. Palmer. 1969. Exchangeable acidity in unburnt colliery spoil. Nature (London) 222(5189):161.

The relationships between the unexchangeable acidity: total cation exchange capacity ratio and acid extractable cations for unburnt spoil samples from three sites is a regression curve. There is a consistent relationship between the degree of saturation of the ion exchange sites with the acidic ions and the neutralizing capacity of the spoil. Spoil which has no net neutralizing capacity is particularly inhospitable to plant growth and establishment.

(Partial abstract from British bibliography, unpubl.).

2A-16-A Chapman, A. G. 1967. Effect of spoil grading on tree growth. Mining Congr. J. 53(8):93-100.

Concerned mainly with the adverse effects of compaction of spoil which inhibits plant growth and causes erosion due to excess water run-off in heavy rains. Experimental plots were established in 1946 and 1947 to find the relative success in growing 17 tree species on graded and ungraded spoil. Survival rate and growth of the trees was better on ungraded spoil which indicates

that complete grading on clayey soils is detrimental to tree establishment.
(From British bibliography, unpubl., p. 32).

2A-17-A Childs, E. C., and E. G. Young. 1959. The use of moisture characteristics curves in assessing the soil stability of opencast coal sites. Proc. Intl. Symp. Soil Structure (1958):415-421.

Crumbs of the 1 to 2 mm fraction of a noncalcareous heavy loam (pH 6) on unworked and worked sites were subjected to slow and quick wetting and the stability of aggregation was estimated by the method of pore size distribution. Moisture-characteristic curves showed little or no difference with slow and quick wetting of the soil from the unworked sites, indicating high stability. No flex point was observed on the moisture curves obtained by quick wetting of crumbs from the worked sites, indicating poor aggregate stability. When pore-size distribution curves were prepared by plotting the slopes of moisture characteristics against suction, stable soils showed peaks in the differentials of both slow and quick wetting moisture characteristics; the peak of the quick wetting curves becomes less and moves to the right of the peak of the slow-wetting curves as aggregates stability declines.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 64).

2A-18-A Churchill, N. J. 1969. Soil survey of Fulton County, Pa. USDA Soil Survey. U.S. Dep. Agric., Washington, D.C. p. 93.

32 series of soil types including strip-mine soils are described. Their engineering properties and suitability for various crops are indicated. Parent materials include residence from shale, siltstone, sandstone, limestone and alluvium.
(From British bibliography, unpubl.).

2A-19 Coleman, G. B. 1951. A study of the water infiltration into spoil banks in central Pennsylvania. J. For. 49(8):574.

2A-20-A Cornwell, S. M. 1966. Anthracite mining spoils as a media for plant growth. Ph.D. Diss. Cornell Univ., Ithaca, N.Y. 187 p.

Site descriptions, classification of spoils, tests conducted. Rate of weathering depends on rock type and pyrite content. Release N, P, K, Ca, Mg, Al, Zn (at least). Mg released preferentially to Ca at the start of weathering. Acid spoil (clay destruction at very low pH) gives a high concentration of elements. Levels of plant available nutrients varied significantly between spoils, as did the number of naturally occurring species on each spoil type. Most spoils--low or moderate amounts of available Na and Ca. Amount of plant available P seemed to determine the plant colonization of the banks. Active fraction in spoils was not the clay and silts (as in soils) but was any fragment with pyrite in them. Final spoil properties for plant growth depended on the mineralogy of the materials, especially the base/pyrite ratio. Therefore, for assessing spoil banks for plant growth, must consider: lithology and weathering processes, must not look at them as soils.

(From British bibliography, unpubl., p. 33).

2A-21-A Cornwell, S. M., and E. L. Stone. 1968. Availability of nitrogen to plants in acid coal mine spoils. Nature (London) 217:768-769.

Nitrogen contents of mature *Betula populifolia* foliage on buff sandstone, gray shale, oxidized surface, "surficial" (mixed deposits of subsoil + unconsolidated substratum), place land (remnants of native soil), and black acid shale were 1.51, 1.68, 1.88, 2.34, 2.41 and 2.47% respectively. Corresponding N contents of the spoils were 0.14, 0.17, 0.16, 0.10, 0.26, and 0.56%. Respective contents of water soluble Al, NO_3. NH_4, and SO_4 of grey shales after 11 months weathering, without leaching, under greenhouse conditions were 0.4-1.6, 0.06-0.22, 0.21-0.47, and 69-171 meq/kg; those of black shales were 21-104, 0.05-0.32, 3.7-8.5, and 66-226.

(From Commonw. Bur. Soils Annot. Bibliogr. 1456. No. 25).

2A-22-A Croxton, W. C. 1928. Revegetation of Illinois coal stripped lands. Ecology 11(2):155-175.

Studies of strip mined areas in Vermillion County showed that water as well as soil acidity, is a critical factor in revegetation. Impermeable acid ridges were barren while other areas of similar acidity but with adequate soil moisture supported growth. Analyses of highly acid base soils showed the presence of nitrogen, phosphorus and potassium, indicating that acidity, not lack of fertility, prevented plant growth. Observation of the natural succession of pioneer plants showed that succession was influenced by acidity of the soil and that vegetation was prevented for long periods on the most acid soils.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R28-1, p. 1).

2A-23-A Cummins, D. G., W. T. Plass, and C. E. Gentry. 1965. Chemical and physical properties of spoil banks in the eastern Kentucky coal fields. U.S. Forest Serv. Res. Note No. CS-17. Central States Forest Exp. Sta., Columbus, Ohio. 11 p.

Ten spoil samples from six major coal-producing seams were analyzed. They showed medium to extreme acidity with generally low concentrations of total soluble salts and organic matter. Exchangeable calcium was low to very low on all spoils and magnesium was abundant; which imbalance may adversely influence plant growth. Available potassium and phosphorus were present in amounts low to adequate for growth. Concentrations of available iron, manganese, aluminum and sulfur probably toxic to many plants were common on extremely acid spoils.
(Adapted from text.)
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R65-7, p. 32).

2A-24* Curtis, W. R. 1971. Strip-mining, erosion and sedimentation.
(See 1A-7-A)

2A-25* Curtis, W. R. 1973. Moisture and density relations on graded strip-mine spoils.
(See 1B-6-A).

2A-26-A Czapowskyj, M. M. 1970. Experimental planting of 14 tree species on Pennsylvania's anthracite strip-mine spoils. U.S. Forest Serv. Res. Note No. NE-155. Northeast. For. Exp. Sta., Upper Darby, Pa. 18 p.

Survival and height growth of 14 species on strip mine spoil heaps (on parent materials of black or grey to yellow shales, sandstones and conglomerates or glacial till) were studied. Hardwoods (poplar, alder, black locust) survived somewhat better and attained considerably better heights than conifers (pine, larch, spruce). Almost all species grew better on graded spoils (compaction effects reduced steepness of slopes) than on ungraded ones. Some properties of the four spoils types (mechanical composition, moisture retention, extractable P, total N, CEC, exchangeable cations, pH) are given in tables.
(From Commonw. Bur. Soils Annot. Bibliogr. 1456. No. 1).

2A-27 Davis, J. D. 1965. Moisture tension in soils and its effect on weed seed germination. Work performed for U.S. AEC under contract (45-1)-1830.

2A-28 Doering, E. J., and W. O. Willis. 1975. Chemical reclamation for sodic strip mine spoils. Agric. Res. Serv., U.S. Dep. Agric., Washington, D.C. 8 p. (ARS-NC-2)

2A-29-A Dougall, B. M. 1950. The effects of opencast coal mining on agricultural land. J. Sci. Fed. Agric. 1:225-229.

This paper deals primarily with the effects of strip mining on the physical structure of the soil. Restoration of the sites to agricultural productivity is also covered.
(Abstracted by Sally Ralston).

2A-30-A Emerson, K., and R. C. Russo. 1976. Soil/sediment chemistry and physics and its effects on pollutants in water, p. 25-31. *In* R. V. Thurston, R. K. Skogerboe, and R. C. Russo (eds.) Quarterly Progress Report--October-December 1975: Toxic effects on the aquatic biota from coal and oil shale development. EPA Internal Project Rep. 5. Colorado State Univ., Fort Collins.

Bentonite and kaolin, two clays representative of clay types found in eastern Montana soils, are under investigation for the development of predictive models for the behavior of potential toxicants introduced into the soil. Preliminary experiments using thin layer chromatography indicate that this is a promising technique as an investigative tool for these clays, and this technique will be used to obtain exchange capacities and migration rates for inorganic ions.
(From author's abstract).

2A-31 Gomez, M., K. Hazen, and E. A. Sondreal. 1970. Prediction of sodium concentration in lignite. Rep. of Investigations No. 7420. Bur. Mines, USDI, Washington, D.C.

2A-32 Gould, W. L., V. W. Howard, and K. A. Valentine. 1972. Soil characteristics, biotic composition and vegetative production of areas leased by Western Coal Company for strip mining near Fruitland, New Mexico. New Mexico Agric. Exp. Sta. Spec. Rep. No. 20. Las Cruces.

2A-33 Grube, W. E. Jr., et al. 1971. Spoil bank chemistry and its relation to plant growth, p. 128-145. *In* M. U. Ahmad (ed.) Proceedings of the acid mine drainage workshop. Ohio Univ., Athens.

2A-34-A Grube, W. E. Jr., R. M. Smith, R. N. Singh, and A. A. Sobek. 1973. Characterization of coal overburden materials and mine soils in advance of surface mining, p. 134-152. *In* First research and applied technology symposium on mined-land reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

Chemical analyses, both in the field and in the laboratory, of sequential samples of overburden can provide information on acid producing potential and plant nutrients available in different zones.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-61, p. 91).

2A-35 Hall, E. P. 1952. Air pollution from coal refuse piles. Mining Congr. J. 48(12):37-41.

2A-36-A Haynes, R. J., and W. D. Klimstra. 1975. Some properties of coal spoilbank and refuse material resulting from surface-mining coal in Illinois. Cooperative Wildl. Res. Lab. (409 251). 137 p. Illinois Inst. for Environmental Quality, Chicago. Southern Illinois Univ., Carbondale. (NTIS PB-251 184/8ST).

The Cooperative Wildlife Research Laboratory surveyed land in Illinois surface mined for coal as of June 30, 1971. Samples of spoilbank material and refuse material were collected and analyzed. The report evaluates the relationships between the spoilbank material and coal seams mined, vegetation density, and age of the spoil material. Also analyzed are the relationships between pH of the spoilbank material and other selected chemical parameters, and the chemical properties of the refuse material (slurry and gob). Results are interpreted and discussed with regard to previously delineated problem areas.

(From NTIS).

2A-37-A Heddleson, M. R., E. P. Farrand, and R. W. Ruble. 1962. Strip-mine spoil reclamation. Public Extension Serv., Coll. Agric., Pennsylvania State Univ., University Park.

This illustrated booklet discusses problems, legislation, planning of reclamation, and characteristics of soil and spoil banks. Careful study and evaluating of any area is necessary to determine what future use is most suitable to its condition.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R64-12, p. 26).

2A-38-A Heide, G. 1957. Fundamentals of agricultural reclamation in the Rhenish brown coal district. Braunkhole 9:86-92.

Some of the soils of the opencast areas are acid and difficult to reclaim. After 10 years some of the soils showed C/N ratios of 6-8. Freshly worked samples had low humus content and contained 60-80 ppm K_2O and P_2O_5. In most areas reclamation is possible.

(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 81).

2A-39 Hodgson, D. R., R. Holliday, and F. Cope. 1963. The reclamation of land covered with pulverized fuel ash: The influence of soil depth on crop performance. J. Agric. Sci. 61:299-308.

2A-40-A Hunter, F., and J. A. Currie. 1956. Structural changes during bulk soil storage. J. Soil Sci. 7:75-80.

Field and laboratory evidence is presented to show that opencast coal working on the heavier boulder clay soils in Northumberland and Durham causes some deterioration in physical structure. It is suggested that anaerobic conditions in the topsoil heaps have affected organic compounds concerned in soil aggregations, and that damage to soil structure is probably inevitable.

(From British bibliography, unpubl., p. 103).

2A-41-A Illner, K., and S. Thomas. 1970. Relationships between moisture contents of certain moisture suctions and texture as well as carbon content of raw spoil heap soils in the brown-coal mining area of Niederlausitz. Albrecht. Thaer. Arch. 14:507-514. (In German, Russian, and English).

Moisture-suction curves, texture, and C content in ameliorated and untreated spoil heaps soils were determined, and the regression equations expressing their relationships (especially between texture and C content, and texture and moisture content at 15 or 0.06 atm. suction) were developed. These relationships were useful in roughly estimating available moisture (0.3-15 atm. suction), and thus the potential productivity of such soils.

(From Commonw. Bur. Soils Annot. Bibliogr. 1456. No. 4).

2A-42-A Krause, R. R. 1973. Predicting mined-land soil, p. 121-131. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 1. Gordon and Breach, New York, N.Y.

The author points out that information about the physical and chemical nature of overburden materials and the influence of the weathering process is needed to predict the best handling use of various overburden layers.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-81, p. 95).

2A-43-A Larosa, P. J., L. A. Karnavas, and E. A. Pelezarski. 1971. Overburden analysis and strip mine conditions in northeastern Ohio. Central States For. Exp. Sta. Tech. Pap. No. 114. U.S. Forest Serv. (Columbus, Ohio). 44 p.

A laboratory study of the variables which affect the properties of the carbonate bonded coal refuse has been made. The carbonate bonding process utilizing coal refuse as a fill material consists of mixing coal refuse with water and lime hydrate, compacting the mixture and reacting it with a carbon dioxide rich gas to form a coherent structure bonded by a matrix of calcite crystals. The resulting carbonate bonded coal refuse can be used in road building or as a coal refuse pile sealant to minimize acid mine water pollution.
(From author's abstract).

2A-44 Limstrom, G. A. 1950. Overburden analyses and strip mine conditions in northeastern Ohio. Central States For. Exp. Sta. Tech. Pap. No. 114. U.S. Forest Serv. (Columbus, Ohio). 44 p.

2A-45 Limstrom, G. 1950. Overburden analyses and strip mine conditions in mideastern Ohio. Central States For. Exp. Sta. Tech. Pap. No. 117. U.S. Forest Serv. (Columbus, Ohio).

2A-46 Limstrom, G. A., and R. W. Mertz. 1951. Overburden analyses and strip mine conditions in the northeastern district of the Ohio coal mining region. Central States For. Exp. Sta. Tech. Pap. No. 124. U.S. Forest Serv. (Columbus, Ohio).

2A-47* Lowry, G. L. 1961. Some physico-chemical characteristics of weathering coal spoils and their influence on the growth of pine seedlings.
(See 1A-15-A).

2A-48-A Massey, H. F. 1972. pH and soluble Cu, Ni, and Zn in eastern Kentucky coal mine spoil materials. Soil Sci. 114(3): 217-221.

Of the three elements studied, Ni appeared to be most likely to remain in the soil solution in toxic amounts once the pH has been adjusted to a point which would otherwise be satisfactory for plant growth.
(From author's summary).

2A-49-A Massey, H. F., and R. I. Barnhisel. 1972. Copper, nickel, and zinc released from acid mine spoil materials of eastern Kentucky. Soil Sci. 113(3):207-212.

Seven samples of spoil material were water leached. The samples were given five successive extractions followed by subsequent leaching. The chemical results are tabulated as metal ions removed. Over a period of 35 weeks the extract of a given material was found to follow one of three patterns: a continued decrease, a decrease followed by an increase, or a continued increase. Appreciable amounts of Cu, Ni, and Zn will be found in coal mine spoils. There is no evidence as to whether these elements contribute to failure or poor growth of plants. An extensive discussion is included on the presence and effects of many ions in soil and water.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R72-35, p. 71).

2A-50 Massey, H. F., and G. C. Johnson. 1965. Solution composition of certain coal mine spoil bank materials as related to soil pH. Presented at Annu. Meeting of the Am. Soc. Agron., Columbus, Ohio.

2A-51-A Mathé, P. 1963. The problem of raw soil formation on crystalline gaunt rock in the High Black Forest. Allg. Forst. Jagdztg. 133:163-172.

A study on research into improvement and reforestation of soils exposed by mining, road-building, etc., of initial soil formation processes on rock or rock shrewn sites on sunny and shady slopes, with special reference to biotic factors. For instance, Beech, sycamore, maple, and silver fir appear to prefer sites at the foot of rocks, possibly because of the nutrients contained in water seeping from complexes of raw soil.

(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 21).

2A-52-A May, R. F. 1964. Surface mine reclamation: Continuing research challenge. Coal Age 69(3):98-99,101.

This is a report on the problems and the research direction in revegetation, hydrology, earth movement and placement, soil mechanics, pyritic-material identification, mined bank chemistry, and haulage roads.

(From Dalsted and Leistritz. 1973 bibliography. No. E-43, p. 21).

2A-53-A May, R. F., and W. A. Berg. 1967. Overburden and bank acidity of eastern Kentucky strip mines. Coal Age 71(6):74-75.

Ten high wall sections were sampled to determine pH values of several coal seam overburden deposits in Kentucky strip mines. The seams selected were upper breathitt, upper middle breathitt, lower middle breathitt, and lower breathitt. The acidity distribution in the overburden over the five Kentucky seams shows that most of the potentially acid material lies immediately over the coal seam or in the partings within the seam. For backfill, it is suggested that a ridge of nontoxic material should be saved at the edge of the bank.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R67-3, p. 41).

2A-54 Merz, R. W., and R. F. Finn. 1951. Differences in infiltration rates on graded and ungraded strip mined land. Central States For. Exp. Sta. Note 65. U.S. Forest Serv. (Columbus, Ohio). 2 p.

2A-55* Moffat, D. J. 1967. A field study into the soil forming factors operating on colliery waste sites.

(See 1C-21-A).

2A-56 Niland, F. A. 1967. The effects of glacial till on spatial variation of reclamation quality of coal strip mine spoil. M.S. Thesis. Ohio State Univ., Columbus.

2A-57-A Oborn, E. T. 1961. Iron content of soils and trees, Beaver Creek strip mining area, Kentucky. U.S. Geol. Surv. Prof. Pap. No. 424B:279-280. USDI, Washington, D.C.

Trees downslope from a mine were richer in Fe and soil was poorer than were upslope trees and soils, respectively.

(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 49).

2A-58-A Pagenkopf, G. K., and P. W. Jennings. 1976. Investigation of organic coal leachates, p. 97-105. *In* R. V. Thurston, R. K. Skogerboe, and R. C. Russo (eds.) Quarterly Progress Report--October-December 1975: Toxic effects on the aquatic biota from coal and oil shale development. EPA Internal Project Rep. No. 5. Colorado State Univ., Fort Collins.

Experiments have shown that the extraction of organic materials from coal is facilitated by hydroxide and oxygen. Acidity, carboxyl, and absorbance measurements indicate that the material removed has properties similar to those typical of humic acids extracted from soils. Solubility measurements on these materials and other experiments show that organics removed are reasonably soluble under conditions typical of groundwater in mined areas.

(From author's abstract).

2A-59-A Petersen, L., K. Rasmussen, and A. T. Jensen. 1967. Soil problems and tree growth after lignite strip mining. Royal Vet. Agric. Coll., Copenhagen Yearbook 1968:35-48.

Lignite clays containing iron pyrites, FeS_2 become very acidic (pH 2-3) on weathering and toxic to plants. An investigation of the pH states of the soil showed that there is a marked correlation between the colouring and pH of soils and its suitability for growing trees. The best tree growth is on soil which consists mainly of whitish quartz sand. The poorest tree growth is on hill tops when the erosion has uncovered a dark brown to violet soil which contains lignite clay and is very acidic.

(From British bibliography, unpubl., p. 47).

2A-60 Pettibone, H. C., and C. D. Kealy. 1971. The engineering properties of mine tailings. Presented at ASCE National Water Resources Engineering Meeting. (January 11-15). Phoenix, Arizona. 13 p. (Available from Spokane Mining Res. Lab., U.S. Bur. Mines, Spokane, Wash.).

2A-61 Power, J. F., J. J. Bond, F. M. Sandoval, and W. Willis. 1974. Nitrification in Paleocene shale. Science 183: 1077-1079.

2A-62-A Power, J. F., R. E. Ries, F. M. Sandoval, and W. O. Willis. 1975. Factors restricting revegetation of strip-mine spoils, p. 336-346. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 3. Eastern Montana Coll., Billings.

Spoils characteristics found to be adverse to revegetation attempts were listed as follows: (1) high exchangeable sodium content, (2) deficiency of plant-available forms of nitrogen and phosphorus, (3) lack of top soil resulting in low moisture contents of the substrate, and (4) the inavailability of soluble chlorides. Measures to correct these deficiencies are described in detail, considering not only their efficacy but the economic feasibility of their large-scale utilization.

(Abstracted by Sally Ralston).

2A-63 Rai, D., P. J. Wierenga, and N. L. Gould. 1974. Chemical and physical properties of core samples from coal bearing formation in San Juan County, New Mexico. Agric. Exp. Sta. Res. Rep. No. 287. New Mexico State Univ., Las Cruces. 13 p.

2A-64 Rauzi, F. 1960. Water intake studies on range soils at three locations in the nothern plains. J. Range Manage. 13:179-184.

2A-65 Ritter, R. E., and C. F. Brown. 1949. Leaching of mine wastes. Proc. W. Va. Acad. Sci. 21:66-67.

2A-66-A Rogers, N. F. 1951. Strip-mined lands of the western interior coal province. Missouri Agric. Exp. Sta. Res. Bull. No. 475. Columbia, Mo.

In this area, consisting of Arkansas, Iowa, Kansas, Missouri, and Oklahoma, about 65,000 acres of land had been strip mined by 1951. The report gives the history of strip mining, the coal seams involved, overburden analyses, character of the strip mined land, uses of reclaimed land, and an inventory of vegetation on strip mined land.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R51-2, p. 5).

2A-67-A Roman, J. C. 1954. An inspection of restored opencast coalsites in Fife. Dep. of Soil Survey, Macauley Inst. for Soil Research, Aberdeen, England. (Unpublished).

A record of the soil profile development on seven restored opencast coal sites in Fife.

(Abstracted by Sally Ralston).

2A-68-A Schulze, E., and M. Ruzanie. 1969. Fertility and productivity of reclaimed loess soils that underwent cultivation for different periods in the brown coal region of Rhineland. Z. Acker. Pflanzenbau. 129:1-28.

There was no substantial difference between the six profiles of soils re-cultivated for 6-33 years after reclamation in a coal-mining region. Unweathered calcareous material (loess marl) brought up from the C horizon showed admixtures of weathered and limeless material (loess loam) from the A and D horizons. There was no significant correlation between the pore space of soils and the length of their cultivation; available (lactate-soluble) K progressively increased with the duration of cultivation and fertilizing, whereas available P showed a marked negative correlation with $CaCO_2$ content. Ratios of C/N in re-cultivated soils were generally satisfactory.

(From Commonw. Bur. Soils Annot. Bibliogr. 1456. No. 19).

2A-69-A Semotan, J. 1962. Application of knowledge on soil-forming processes for the reclamation of industrial wastes. Int. Soil Conf. N.Z.:864-871 (In German).

A general account is given under the headings: Characteristics of overburden from the standpoint of

reclamation; enrichment of overburden soils by organic matter, application of geological and soil evaluation of overburden soils in tailing reclamation.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 36).

2A-70 Smith, R. M., W. E. Grube, and J. T. Ammons. 1973. Toxic or potentially toxic materials. West Virginia Agric. Exp. Sta. Sci. Paper No. 1297. Morgantown, W. Va. Also in Green Lands 3(3):7.

2A-71 Smith, R. M., R. N. Singh, and W. E. Grube. 1972. Properties of coal overburden that influence plant growth on mine spoils. *In* M. U. Ahmad (ed.) Proceedings of the acid mine drainage workshop. Ohio Univ., Athens.

2A-72 Sobek, A. A. 1972. Properties of barren mine spoils that influence revegetation. M.S. Thesis. West Virginia Univ., Morgantown.

2A-73 Stevenson, F. J. 1965. Origin and distribution of nitrogen in soil, p. 1-42. *In* W. V. Bartholomew (ed.) Soil nitrogen. Agron. Ser. No. 10. Am. Soc. Agron., Madison, Wisc.

2A-74* Struthers, P. H. 1964. Chemical weathering of strip-mine spoils.
(See 1A-19-A).

2A-75-A Struthers, P. H., and J. P. Vimmerstedt. 1965. Rapid strip-mine reclamation. Ohio Rep. Res. Development 50(6):84-85,87.

Rain percolating through spoil leaches salts from the weathered material, improving the spoil banks. When spoil materials are exposed to the atmosphere, soluble salt production begins intensively. This is usually at a peak the first year and then diminishes gradually. The formation of mineral salts cannot be prevented but their harmful effect on plants can be reduced by grading for entry and passage of more water through the spoils.
(Abstracted by Sally Ralston).

2A-76-A Sutton, P. 1973. Establishment of vegetation on toxic coal mine spoils, p. 153-158. *In* First research and applied technology symposium on mined-land reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

These studies to find methods to establish vegetation on toxic spoil were carried out in Noble County, Ohio. The results indicate that vegetation can be established by covering toxic spoils with suitable material, by use of limestone to neutralize acidity, by the addition of organic materials such as sewage sludge or manure, and by suitable plant species. However, root systems are confined to non-toxic or treated layers.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-146, p. 108).

2A-77-A Tasker, J. 1957. Restoration of opencast coal land. Agriculture (London) 64(7):329-332.

This article, based on experience in the West Riding of Yorkshire, is concerned mainly with the physical restoration of the topsoil, both from the aspects of its mechanical state and the build up of fertility. The stage under review is that between the contractors completing the restoration of the site and this being considered satisfactory for handing back to the farmer.

(From Herbage Abstr. 28).

2A-78 Taylor, H. M., J. J. Parker, and G. M. Roberson. 1966. Soil strength and seedling emergence relations. Agron. J. 58:4.

2A-79 Tobaben, D. J. 1969. Limnology of strip mine lakes and chemical analysis of spoil materials. M.S. thesis. Kansas State Coll., Pittsburgh, Pa.

2A-80-A Valek, B. 1963. The importance of calcium on the toxicity of the soil during sulphide-oxidation weathering in soil or mine dumps. Casopis pro Mineralogii a Geologii 8:198-202.

When Ca is present in sufficient quantity, sulphide oxidation is slow...

(From Commonw. Bur. Soils Annot. Bibliogr. 1027. p. 24).

2A-81-A Van Lear, D. H. 1971. Effects of spoil texture on growth of K-31 tall fescue. U.S. Forest Serv. Res. Note No. NE-141. Northeast. For. Exp. Sta. 7 p.

The growth of K-31 tall fescue was significantly affected by the particle size distribution or texture, of four spoils from eastern Kentucky. Growth on non-toxic spoils was greatest where the texture consisted of about equal quantities of soil-size material and a coarser fraction (2mm to 6.4 mm) probably because moisture and aeration were more favorable. On two spoils adverse chemical properties modified the effect of physical properties associated with texture. Toxic levels of Mn found in the smaller size fractions probably reduced yields on one spoil. On another the effect of texture was masked by toxic levels of Al in each of the three particle size fractions.

(Abstracted by author).

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R71-46, p. 63).

2A-82-A Weigle, W. K. 1965. Designing coal-haul roads for good drainage. Central States Forest Exp. Sta. U.S. Forest Serv. (Columbus, Ohio). 23 p.

This article concerns proper methods of controlling drainage for the purpose of maintaining good coal-haul roads. Road designs with drainage culverts and ditches are shown. Recommendations for check dams are included.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R65-28, p. 35).

2A-83-A Wilson, H. A., and H. G. Hedrick. 1960. Extractable sulphates and iron in strip mine spoil acid spots. Proc. W. Va. Acad. Sci. 31/32(1959-1960):21.

Acid spots on strip mine soil are assumed to arise from Fe polysulphides which oxidize biologically to H_2SO_4. The pH was 2.05 to 5 at centers of the spots and 2.45 to 8 outside of the spots. Soluble SO_4 was 23 to 554 ppm for samples from spots, 3 to 120 ppm from outside the spots, and 0 to 23 ppm for soil with no visible spots. The total Fe was 44 to 5,000 ppm in spots, 3 to 131 ppm for spoil outside the spots and 4 to 25 ppm for samples with no visible spots.

(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 59).

2A-84 Wilson, H. A., and G. Stewart. 1955. Ammonification and nitrification of a strip mine spoil. W. Va. Agric. Exp. Sta. 379T. Morgantown, W. Va. Also in Wildl. Rev. 85:20. (Abstr.).

2A-85 Wischmeier, W. H., and J. V. Mannering. 1969. Relation of soil properties to its productivity. Soil Sci. Soc. Am. Proc. 33:131-137.

2A-86 Zimmerman, R. E. 1952. Atmospheric pollution problem of mine refuse piles, p. 73-83. *In* L. C. McCabe (Chairman) Air pollution. Proceedings of the United States Technical Conference on Air Pollution. McGraw Hill Book Co., Inc., New York, N.Y.

B. Biology of Disturbed Soils: Microbiology, Plant Growth and Succession, Etc.

2B-1-A Bankworth, H., and M. Bateson. 1964. An investigation into the bacteriology of topsoil dumps. Plant Soil 21(3): 345-353.

Topsoil dumps of differing ages at opencast coal sites ironstone workings and gravel pits were sampled at the surface and at three feet intervals throughout the dumps. Counts of the total colonies and anaerobes and the presence of nitrifying and cellulose decomposing organisms indicate that bacteria die out very slowly and occur in reasonably high numbers (representative of the normal flora of the soil) even in the oldest dumps.

(From British bibliography, unpubl., p. 103).

2B-2-A Berg, W. A., and W. G. Vogel. 1973. Toxicity of acid coal-mine spoils to plants, p. 57-68. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 1. Gordon and Breach, New York, N.Y.

Manganese and aluminum toxicity to herbaceous legumes, shrub lespedezes, and black locust was assessed in greenhouse and field trials using extremely acid spoils.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-16, p. 81).

2B-3-A Bode, E. 1975. Pedozoological investigations on recultivated soils of brown coal spoil heaps. Pedobiolgia 15(4):284-289. (In German with English Summary).

Springtail associations from different ages of coal spoil were investigated.

(Abstracted by Sally Ralston).

2B-4* Cornwell, S. M., and E. L. Stone. 1968. Availability of nitrogen to plants in acid coal mine spoils.

(See 2A-21-A).

2B-5-A Crampton, C. B. 1967. Soil development on tips in South Wales. Sylva 47. 3 p.

A description of the soil profiles which develop on coal tips under different species, notably Japanese larch (*Larix leptolepis*), Scots pine (*Pinus sylvestris*), lodgepole pine (*Pinus contorta* var. *latifolia*), and Corsican pine (*Pinus nigra* var. *calabrica*).

(From British bibliography, unpubl., p. 103).

2B-6-A Davison, A., and B. J. Jeffries. 1966. Some experiments on the nutrition of plants growing on coal mine waste heaps. Nature (London) 210:649-650.

Typical pit heap species were grown from seed in numerous contrasting pit heaps soils treated with different nutrient solutions. All soils were severely deficient in P and N, but the response to P or N depended on the species and soil pH.
(Abstracted by Sally Ralston).

2B-7 Dekock, P. C., and E. L. Strmecki. 1954. An investigation into the growth promoting effects of lignite. Plant Physiol. 7:503-512.

2B-8-A Dobson, A. L., and H. A. Wilson. 1964. Refuse decomposition in stripmine spoils. Proc. W. Va. Acad. Sci. 35:59-65.

When household refuse is deposited on abandoned strip mine areas, the type of covering material has little effect on the rate of decomposition. The refuse contained sufficient microorganisms to initiate and continue decomposition.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 8).

2B-9 Dugan, P. R. 1975. Bacterial ecology of strip mine areas and its relationship to the production of acid mine drainage. Ohio J. Sci. 75(6):266-279.

2B-10-A Dunger, W. 1967. The development of the macro and megafauna in reclaimed spoil heaps, p. 340-352. *In* O. Graff and J. E. Satchell (eds.) Progress in soil biology. Friedr. Vieweg & Sohn GmbH, Braunshweig, Germany. (In German).

Faunal colonization of these acid spoil heaps from brown coal mining is slow until reclamation or afforestation, when it occurs promptly. 200 phagous and saprophagous arthropods and enchytracids are the first to appear (1-4 years). Lumbricids appear after 5 years if the vegetation is then 60% or more. *Allobophora caliginosa* and *Dendrobeana octaedira* were the first pioneers. After 10-12 years, the macro- and megafauna had about the same biomass as a neighboring natural ash-elm association.
(From Commonw. Bur. Soils Annot. Bibliogr. 1456. No. 40).

2B-11-A Dunger, W. 1969. Problems of the natural and experimental colonization with lumbricids, of soils unsuitable for cultivation. Pedobiologia 9:146-151. (In German).

Dumps and tips from opencast mining of brown coal became colonized with earthworms within as short a time as ten years. The pioneer species *Allolobophora caliginosa* succeeded *Dendrobeana octraedra*; after 10-15 years *Lumbricus rubellus* and *L. terrestris* became numerous. Colonization is presented or retarded by admixture of tertiary sand and is promoted by leaf mulch.
(From Commonw. Bur. Soils Annot. Bibliogr. 1456. No. 12).

2B-12-A Dunger, W. 1969. The role of arthropods in litter decomposition and the initial stages of soil formation. Pedobiologia 9:366-371. (In German).

In the early stages of soil formation on reclaimed spoil heaps of opencast coal mining, the arthropods fauna (especially Diptera and Collembola) developed first, their total annual respiration (in a 3-year old population) amounting to 94% of that of the total fauna. After 10 years the contribution of arthropods dropped to 6%. Litter decomposition increased from 4.6 to 76.3% during this period.
(From Commonw. Bur. Soils Annot. Bibliogr. 1456. No. 13).

2B-13-A Einspahr, D. W., A. L. McComb, F. F. Riecken, and W. D. Schader. 1955. Coal spoil-bank materials as a medium for plant growth. Proc. Iowa Acad. Sci. 62:329-344.

This paper reports work on a number of Iowa spoil banks to learn their ability to sustain plant and tree life. Iowa spoil material has a high percentage of particles less than 2 mm in size and their textures are of the silty clay loam type. Liming of the toxic spoil was not practical from an economic standpoint and the results achieved with moderate lime treatments were only temporary. Shale derived soils in southeast Iowa are of low productivity and the very acid spoils weathered at a very slow rate. Best yields were obtained from nitrogen-phosphorus treatments on neutral light gray shale. Black calcareous shales were the spoil materials best suited for plant growth and toxic gray shales of the brownstone type were the least suited. Graphs and tables present data from the various investigations.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. 55-2, p. 7).

2B-14-A Evans, H. C. 1972. Thermophilous fungi isolated from the air. Trans. Br. Mycol. Soc. 59(3):516-519.

Fungi were collected from the air over coal spoil tips to be compared with fungi within the spoil tips. The dominants were: *Asperillus fumigatus* (49.8%), *Thermomyces lanuginosus* (16.6%), and *Mucor pusillus* (14.1%).
(Abstracted by Sally Ralston).

2B-15 Geyer, W. A., and N. F. Rogers. 1972. Spoil change and tree growth on coal mined spoil in Kansas. J. Soil Water Conserv. 27:114-116.

2B-16-A Greenwood, E. F. 1963. Studies in the spread of plants onto pit heaps with special reference to the water relation of colonizing species. M.S. Thesis. Univ. Durham, England. 218 p.

15 heaps in Durham County were investigated (10 in detail) for: (1) Composition and shape; (2) the vegetation-species list and frequency occurrence, (3) Effect on plants of erosion of one heap; (4) Chemical properties; (5) Physical properties-mechanical composition and water holding capacity; (6) Climate; (7) Arrival of seeds, germination, establishment and survival rates; (8) Drought resistance and transpiration rates of plants; and (9) Movement of water through plants from soil using autoradiographic and counting techniques.

(From British bibliography, unpubl., p. 21).

2B-17-A Hall, I. G. 1956. The ecology of disused pit heaps in England. J. Ecol. 45(3):689-720.

The configuration and type of spoil are the main factors affecting the distribution of natural vegetation on tips. The plants were grouped into life forms in the Raunkian system. All forms were found to be in the same proportion as on undisturbed land. The important factors in determining natural vegetation on spoil heaps are considered to be seed source and pH.

(From British bibliography, unpubl.).

2B-18-A Harding, C. P. 1970. Plant available nutrients in colliery spoil and their relations to ecotypic differentiation within population of *Agrostis tenuis* L. Ph.D. Diss. Univ. York, England.

Analysis of spoil from 8 different tips in Yorkshire of spoil bioassay methods, saturation paste analysis and a comparison of the results given. Concentration Al, Mn, and Fe were high in spoil and plants grown in spoil, with those of P and K low.

Experiments were carried out with tip and non-tip populations of *Agrostis tenuis* to determine whether tip populations showed adaptations to soil conditions. Transplant experiments gave no conclusive evidence that non-tip populations did.

Rooting experiments showed that Mn was not toxic to plant growth under spoil conditions and the population did not show adaptation to high concentrations. Soluble Al concentrations was high in spoil but presence of other ions reduces the Al toxicity.

Nutrient tests showed that plant yield of tip populations was increased by the addition of P or K, at low concentrations. Apparently the plants had adapted to spoil conditions of available P, N, K. The significance of variation over the tip surface is discussed with regard to its effect on the formation of ecotypes and reclamation schemes.

(From British bibliography, unpubl., p. 21).

2B-19-A Hedrick, H. G., and H. A. Wilson. 1956. The rate of carbon dioxide production in a strip mine spoil. Proc. W. Va. Acad. Sci. 28:11-15.

In this project several chemical agents were used to treat nonvegetated and vegetated spoil materials to see how the treatment affected the rate of carbon dioxide production by soil microbes. Agents used were calcium hydroxide, sodium nitrate, phosphorus as calcium phosphate, potassium as potassium phosphate and nitrogen. Under laboratory conditions the CO_2 production was greater when nitrogen was added to the spoil material. Second in importance was the addition of calcium hydroxide to produce a more favorable pH. Phosphorus and potassium had little or no effect on the daily rate of carbon dioxide production. Ground straw was used as a supplemental source of organic matter for use as an energy source by the microbes.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R56-3, p. 9).

2B-20 Hunter, F., and J. Pringle. 1966. Soil fertility studies on restored opencast coal sites. Chem. Ind. (London) 20:790.

2B-21 Jackson, W. A. 1967. Physiological effects of soil acidity, p. 43-124. *In* Soil acidity and liming. Am. Soc. Agron., Madison, Wisc.

2B-22-A Neumann, U. 1971. Succession of soil fauna in afforested spoil banks of the brown-coal mining district of Cologne. Pedobiologia 11:193-226. (In German with English summary). Also in 1973, p. 335-348. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 1. Gordon and Breach, New York, N.Y.

Fauna, as well as bacteria, break down plant and leaf litter to form good soil. Three different fauna were investigated in this study. Results show that development of fauna on spoil was dependent on a cool moist micro-climate, especially digestible leaf litter, soil moisture, and availability of species by migration or by other means of introduction.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-98, p. 98).

2B-23 Pulford, I. D., and H. J. Duncan. 1975. The influence of pyrite oxidation products on the absorption of phosphate of coal-mine waste. J. Soil Sci. 26(1):74-80.

2B-24 Saxton, K. E., H. P. Johnson, and R. H. Shaw. 1974. Modeling evapotranspiration and soil moisture. Trans. ASAE 17(4):673-677.

2B-25-A Struthers, P. H. 1961. 180,000 stripmine acres: Ohio's largest chemical works. Ohio Farm Home Res. 46(4):2 p.

Chemicals leached from Ohio strip mine spoils are described. It is suggested that the ready availability of minerals may account for the acid mine tolerance of many plants on strip mine spoils.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R61-10, p. 16).

2B-26 Szabo, B. 1974. Study of microbiological problems in reclamation experiments of soil banks in coal strip mining. Agrartud Kozl 33(1):157-160.

2B-27-A Temple, K. L., and F. Kimble. 1976. Quality of leach water from Montana coal mine spoils, p. 129-137. *In* Toxic effects on the aquatic biota of coal and oil shale development. EPA Quarterly Progr. Rep., Natural Resource Ecology Lab, Fort Collins, Colo.

Five overburden cores from the Ashland, Montana region have been examined. Each core was visually inspected for obvious mineralization to supplement the geologists' log, and criteria were adapted for the routine screening of core samples. Some cores have been ground and seived for leaching. Additional bacteria, expected to be tolerant to metals, have been obtained for leaching experiments.

(From author's abstract).

2B-28-A Thompson, H. W. 1958. Restoration of agricultural and other soils. Nature (London) 181:390-391.

A report of two papers read at a meeting of the Association of Applied Biologists. One by R. Holliday and D. R. Hodgson on "Restoration of land covered by pulverized fuel ash" dealt with the use of fertilizers, reduction of alkalinity, dilution of the ash with bulky materials and field trials with various crops. The second paper by H. W. Thompson on "Some biological aspects of open-cast coal working" dealt with changes in surface soil during opencast working resulting in undesirable qualities; these include destruction of drainage, spread of pests such as nematodes and reduction in numbers of earthworms.

(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 78).

2B-29 Vimmerstedt, J. P., and J. H. Finney. 1973. Impact of earthworm introduction on litter burial and nutrient distribution on Ohio strip-mine spoil banks. Soil Sci. Soc. Am. Proc. 37(3):388-391.

2B-30-A Wilson, H. A. 1956. The number of bacteria, fungi and actinomycetes in some strip mine spoil. W. Va. Agric. Exp. Sta. Bull. 388T. Morgantown, W. Va. 15 p.

Numbers were determined in 4 stripmined areas for the 0-4 and 4-8 inch layers of (a) vegetated and (b) non-vegetated spoil and for (c) nearby undisturbed soil. In (b) numbers were larger in the 4-8 inch layers; in (a) whether under grasses and legumes, pine or black locust, numbers were larger in the 0-4 inch layer, being in a few cases larger than in (c). Certain physical groups were determined in 2 of the areas. Azobacteria was absent even in samples of pH 6. Nitrifiers were present only in (c). Nitrifiers were present only in (a) of one of the areas. Ammonifiers denitrifiers and cellulose decomposers were much more numerous in (a) than in (b). S-oxidizers in one area decreases as H-ions concentration decreased. Twenty-two genera of fungi were identified, 9 only in spoil and 3 only in soil.
(From British bibliography, unpubl., p. 55).

2B-31-A Wilson, H. A. 1957. Effect of vegetation upon aggregation in strip mine spoils. Soil Sci. Soc. Am. Proc. 21:637-640.

Evaluation of material from vegetated and nonvegetated portions of strip mine spoils and adjacent unmined soils showed that aggregation of undisturbed land is greater than that of vegetated land which is greater than aggregation of barren lands. A good cover of grasses and legumes has a more stimulating effect on aggregation than black locusts which in turn are more effective than pines.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R57-5, p. 10).

2B-32 Wilson, H. A. 1965. The microbiology of strip mine spoils. W. Va. Agric. Exp. Sta. Bull. 506T. Morgantown, W. Va. 44 p.

2B-33-A Wilson, H. A., and H. G. Hedrick. 1957. Some qualitative observations of the microflora in a strip mine spoil. W. Va. Agric. Exp. Sta. Bull. 29. Morgantown, W. Va. p. 35-38.

Small numbers of bacteria, fungi, and actinomycetes were found on shales buried in unvegetated strip mine spoil, of pH 3.7; in vegetated areas the organisms were

more numerous. Additions of straw to the spoil somewhat increased populations but additions of lucerne resulted in the greatest increase.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 87).

2B-34 Wind, G. P. 1957. Root growth in acid soil. Neth. J. Agric. Sci. 15:259-260.

C. General Soil Biology and Ecology

2C-1 Alexander, M. 1969. Soil decomposers, p. 403-409. *In* R. L. Dix and R. G. Beidleman (eds.) The grassland ecosystem: A preliminary synthesis. Range Sci. Dep. Sci. Ser. No. 2 Colorado State Univ., Fort Collins.

2C-2* Alizai, H., and L. C. Hulbert. 1970. Effects of soil texture on evaporative loss and available water in semi-arid climates.
(See 2A-1-A).

2C-3 Bear, F. E. 1957. Toxic elements in soils. U.S. Dep. Agric. Yearbook, Soils. p. 165-171.

2C-4 Birch, H. F. 1960. Nitrification in soils after different periods of dryness. Plant Soil 12:81-96.

2C-5 Branson, F. A., G. F. Gifford, and J. R. Owen. 1972. Rangeland hydrology. Range Science Series No. 1. Soc. Range Manage., Denver, Colo. 84 p.

2C-6 Branson, F. A., R. F. Miller, and I. S. McQueen. 1962. Effects of contour farrowing, grazing intensities and soils on infiltration rates, soil moisture and vegetation near Fort Peck, Montana. J. Range Manage. 15:151-158.

2C-7 Brierly, J. K. 1956. Some preliminary observations on the ecology of pit heaps. J. Ecol. 44(2):383-390.

2C-8 Crawford, B. T. 1950. Some specific relationships between soil and wildlife. J. Wildl. Manage. 14(2):115-123.

2C-9 Dunnewald, T. J. 1957. Wyoming soils and soil material. Agric. Exp. Sta. Bull. 349, Univ. Wyoming, Laramie. 24 p.

2C-10 Eckert, R. E., Jr., G. J. Klomp, J. A. Young, and R. A. Evans. 1970. Nitrate-nitrogen status of fallowed rangeland soil. J. Range Manage. 23(6):445-447.

2C-11 Gray, D. M., D. I. Norum, and J. M. Murray. 1969. Infiltration characteristics of prairie soils. Annu. Meeting Am. Soc. Range Manage., 10-13 February, Calgary, Canada.

2C-12 Guernsey, J. L. 1967. Selected effects of glacial till on the physical characteristics and existing land use of Indiana's strip mine land. Proc. Indiana Acad. Sci. 77:158-164.

2C-13 Gumbs, F. A., and B. P. Warkentin. 1975. Prediction of infiltration of water into aggregated clay soil samples. Soil Sci. Soc. Am. Proc. 39(2):255-263.

2C-14-A Knabe, W. 1964. Methods and results of strip-mine reclamation in Germany. Ohio J. Sci. 64(2):75-106.

Classification of overburden layers and estimation of their fertility are necessary before mining begins so that the toxic layers can be covered by inert or fertile layers of soil when the operations are complete. This eliminates the problem of reclaiming toxic wastes. The mining equipment used in Germany are described and illustrations show each layer of overburden is removed, separately. Ameliorative treatments for the new soil surface are briefly discussed. The main land use after mining in Germany is for forestry and the relative success of different species is discussed.
(From British bibliography, unpubl., p. 43).

2C-15 McColley, P. D., and H. S. Hodgkinson. 1970. Effect of soil depth on plant production. J. Range Manage. 23(3): 189-192.

2C-16* Meeuwig, R. D. 1970. Infiltration and soil erosion as influenced by vegetation and soil in Northern Utah. (See 1C-19).

2C-17-A Miller, D. E., and W. H. Gardner. 1962. Water infiltration into stratified soil. Soil Sci. Soc. Am. Proc. 26(2): 115-119.

A laboratory investigation was made of the effects of textural and structural stratification within the profile on rate of water infiltration into soil.
(Abstracted by Sally Ralston).

2C-18 Noble, E. A. 1974. A geologist's viewpoint of strip mining. North Dakota Geol. Surv. Educ. Ser. No. 5. North Dakota Acad. Sci., Grand Forks. p. 53-60.

2C-19 Omodt, H. W., F. W. Schroer, and D. D. Patterson. 1975. The properties of important agricultural soils as a criteria for mined land reclamation. North Dakota Agric. Exp. Sta. Bull. 492. 52 p.

2C-20 Power, J. F., J. Alessi, G. A. Reichman, and D. C. Grimes. 1973. Recovery, residual effects and fate of nitrogen fertilizer sources in a semi-arid region. Agron. J. 65:765-768.

2C-21* Power, J. F., et al. 1974. Nitrification in Paleocene shales. (See 2A-61).

2C-22 Richter, W. C. 1961. Toil with spoil. Pa. Game News 32(7): 39-41.

2C-23 Rickard, W. H. 1964. Demise of sagebrush through soil changes. BioScience 14:43-44.

2C-24 Rule, G. K. 1941. Toward soil security on the northern Great Plains. U.S. Dep. Agric., Farmer's Bull. 1864. 76 p.

2C-25 Thorp, J., B. H. Williams, and W. I. Watkins. 1948. Soil zones of the Great Plains states--Kansas to Canada. Soil Sci. Soc. Am. Proc. 13:438-445.

2C-26 Ting, F. T. C., et al. 1972. Depositional environments of lignite-bearing strata in western North Dakota. Misc. Series No. 50. North Dakota Geological Survey, Grand Forks, N.D.

2C-27 Van der Ploeg, R. R., and P. Benecke. 1974. Unsteady, unsaturated, N-dimensional moisture flow in soil: A computer similation program. Soil Sci. Soc. Am. Proc. 38(6):881-885.

2C-28 White, E. M. 1971. Some soil age-range vegetation relationships. J. Range Manage. 24:360-365.

2C-29 Wildung, R. E., J. W. Bigger, and G. Charles. 1969. Soil perfusion under controlled conditions of soil moisture content and soil atmospheric composition. Soil Sci. Soc. Am. Proc. 33:813-814.

2C-30 Wildung, R. E., B. F. Hajek, and K. R. Price. 1968. Chemical properties of the arid soil organic fraction: Comparative chemical properties of plant lignins and soil humic acids. Rep. No. BNWL-982. Battelle Northwest Lab., Richland, Wash.

III. AQUATIC COMPONENTS

A. Impact of Strip Mining on the Physical and Chemical Parameters of Local and Regional Water Resources

3A-1 Ahmad, M. U. 1973. Strip mining and water pollution. Ground Water 11(5):37-41.

3A-2 Barnes, H. L., and S. B. Romberger. 1968. Chemical aspects of acid mine drainage. J. Water Pollut. Control Fed. 40(3):371-384.

3A-3-A Braley, S. A. 1961. Mine acid control. *In* Mellon Inst. Industrial Research 1960 Annu. Rep. 48:28. Mellon Inst., Pittsburgh, Pa.

Deals with the effect of water impoundment in pits from strip-mining operations.
(Abstracted by Sally Ralston).

3A-4* Brezina, E. R., et al. 1970. Effects of acid mine drainage on water quality of a reservoir.
(See 1A-5-A).

3A-5 Campbell, R. S., and O. T. Lind. 1969. Water quality and aging of strip mine lakes. J. Water Pollut. Control Federation 41(11):1943-1955.

3A-6 Campbell, R. S., et al. 1965. Recovery from acid mine pollution in four strip mined lakes: Summary progress report 1967-1968. Univ. Missouri, Columbia. (Mimeo).

3A-7 Campbell, R. S., et al. 1965. Recovery from acid pollution in shallow stripmined lakes in Missouri. Engineering Extension Ser. No. 117. Purdue Univ., Lafayette, Ind. Also in Eng. Bull. 49(1a):17-26.

3A-8 Caruccio, F. T., and R. R. Parizek. 1967. Evaluation of factors affecting acid mine drainage production from various strata of the Allegheny group and the ground water interactions in selected areas in western Pennsylvania. Ph.D. Diss. Pennsylvania State Univ., University Park. 213 p. Also in Diss. Abstr. B29(1):245-246.

3A-9 Corbett, D. M. 1969. Acid mine drainage problem of the Patoka River watershed, southwestern Indiana. Rep. of Investigations No. 4. Water Resources Res. Center, Indiana Univ., Bloomington. 173 p.

3A-10 Corbett, R. G., E. B. Nuhfer, and H. W. Phillips. 1967. Im Trace elements in bituminous mine drainage and associated sulfur minerals. Proc. W. Va. Acad. Sci. 39:311-314.

3A-11 Dambach, C. A. 1966. Acid mine drainage control: The key to recreational development in southeastern Ohio, p. 165-186. *In* Proceedings of 2nd Symposium on Water Resources Research, Ohio State Univ., Columbus.

3A-12 Deane, J. A. 1966. How strip mining improves mid-west water supplies. Coal Age 71(5):66-68.

3A-13* Emerson, K., and R. C. Russo. 1976. Soil/sediment chemistry and physics and its effects on pollutants in water. (See 2A-30-A).

3A-14 England, R. H., and K. B. Cumming. 1972. Stream damage from manganese strip mining. Proc. Annu. Conf. Southeast Assoc. Game Fish Comm. 25:399-418.

3A-15-A Etter, H. M. 1971. Preliminary report of water quality measurements and revegetation trials on mined land at Luscar, Alberta. Internal Rep. NOR-3. Canadian Forestry Service, Northern Forest Research Centre, Edmonton, Alberta. 19 p.

Primarily deals with water sampling in an area of weathered sandstone and shale overburden. (Abstracted by Sally Ralston).

3A-16 Gay, H. R. 1967. Acid mine contamination of the West Fork River above Clarksburg, West Virginia. Presented to the Clarksburg Water Board, Clarksburg, W. Va., 8 September 1967. (Mimeo).

3A-17-A Kimmel, W. G., and W. E. Sharpe. 1973. Acid drainage and the stream environment. Trout 17:21-25.

A review of the nature of the problem of the introduction of acid materials to trout streams, its ecological consequences and remedial measures. The principal sources of acid drainage are the sites of anthracite and bituminous coal strip mines. The presence of large quantities of limestone in the mining areas tend to neutralize the toxic effects. A brief discussion of the revegetation of surface-mined lands is included. (From author's abstract).

3A-18 Lewis, W. M., and C. Peters. 1955. Physico-chemical characteristics of ponds in the Pyatt, Desoto, and Elkville strip mined areas of southern Illinois. Trans. Am. Fish Soc. 84(1955):117-124.

3A-19 McWhorter, D. B., R. K. Skogerboe, and G. V. Skogerboe. 1974. Potential of mine and mill spoils for water quality degradation. Presented at Proc. Am. Water Resources Assoc., Symp. on Water Resources Problems Related to Mining. Golden, Colo.

3A-20 McWhorter, D. B., R. K. Skogerboe, and G. V. Skogerboe. 1974. Water pollution potential of mine spoils in the Rocky Mountain region, p. 25-35. *In* 5th Symp. on Coal Mine Drainage Research. National Coal Assoc., Washington, D.C.

3A-21 Neeley, J. D. 1971. The effects of strip mining on a natural system: A water quality study of Piedmont Lake, Ohio. Biol. 933, Intersession Project. Case Western Reserve Univ., Cleveland, Ohio. (Mimeo).

3A-22 Neeley, J. D., et al. 1971. The ecological effects of strip mining: A comparative study of natural and reclaimed watersheds. Presented at Case Western Reserve Univ., Cleveland, Ohio, 20 August 1971. (Mimeo).

3A-23-A Northeastern Forest Experiment Station. Freeing streams from mud and flood. Photo Story No. 13. Northeast. For. Exp. Sta., U.S. Forest Serv. (Upper Darby, Pa.).

The first 6 months after completion of strip mining on steep terrain are critical to the quality of both the land and water resources nearby. This brief photo story describes research by the Northeastern Forest Experiment Station on terracing methods to prevent sediment and erosion from recent spoil banks.
(Abstracted by Sally Ralston).

3A-24-A Northeastern Forest Experiment Station. Toward a quality water supply. Photo Story No. 10. Northeast. For. Exp. Sta., U.S. Forest Serv. (Upper Darby, Pa.).

A brief description of the effect of strip mining on local waterways and efforts of the Northeastern Forest Experiment Station to control the resultant disturbances in water quality.
(Abstracted by Sally Ralston).

3A-25 Pagenkopf, G. K., C. Whitmore, and W. Van Voast. 1975. Influences of spoil materials on ground water quality. Presented to Am. Chem. Soc., Div. of Environmental Chemistry, Philadelphia, Pa.

3A-26 Porges, R., L. A. Vandenberg, and D. G. Ballinger. 1966. Reassessing an old problem: Acid mine drainage. J. Sanitary Eng. Div., Proc. Am. Soc. Civil Eng. 92(SA1):69-83.

3A-27-A Rahn, P. H. 1975. Ground water in coal strip-mine spoils, Powder River Basin, p. 348-361. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 3. Eastern Montana Coll., Billings.

Large quantities of strip-mine waste will ultimately be replaced in mined out areas of the Powder River Basin, Wyoming and Montana. This study concerns the hydrologic characteristics of the waste, and the chemistry of the water which occurs in the spoils.

Preliminary observations indicate that the porosity of stripped overburden increases when it is dumped as spoils. The permeability of the spoils varies greatly from mine to mine and depends in part on the local stratigraphy. The permeability also depends on the mechanical equipment used in removing and transporting the overburden.

Water table levels indicate that the spoils at the Wyodak, Bell Ayr, Big Horn, and Decker mines will become saturated to varying degrees upon abandonment. Where these spoils are permeable, they will become man-made aquifers.

(Abstracted by Sally Ralston).

3A-28 Rouse, J. V. 1970. Acid mine drainage from hard rock mines of the West. Presented at Proc. Summer Workshop on Air and Water Pollution, Univ. Colorado, Boulder.

3A-29 Singer, P. C., and W. Stumm. 1970. Acid mine drainage, the rate-determining step. Science 167:1121-1123.

3A-30-A Skogerboe, R. K. 1976. Characterization of soluble organics in mine overburden and aqueous effluents, p. 121-127. *In* R. V. Thurston, R. K. Skogerboe, and R. C. Russo (eds.) Quarterly progress report--October-December 1975: Toxic effects on the aquatic biota from coal and oil shale development. EPA Internal Progress Rep. No. 5. Colorado State Univ., Fort Collins, Colo.

Water quality data accumulated to date have been examined to determine the maximum observed concentration ranges and most typical values of the parameters measured. Equilibria calculations based on these results have been used to define those equilibria most prominent in controlling the solubilities of potentially toxic heavy metals and to estimate the maximum solubilities of these for the streams in question. Comparisons of the computed and observed concentrations have been used to predict whether other unrecognized equilibria may be operative or to indicate metals for which toxicity problems may be anticipated. Groundwater and leachate analyses indicate that waters in contact with coal overburden are bicarbonate buffered at a pH of approximately 8; have high alkalinity, hardness and sulfate concentrations; are low in chloride, nitrate and orthophosphate; and typically exhibit concentrations of Pb, Cd, Hg, As, Se, Mo, and Cr below 10 µg/liter. Preliminary identification experiments indicate that both saturated alkanes and organic esters are present.

(From author's abstract).

3A-31-A Smith, R. W., and D. G. Frey. 1971. Acid mine pollution effects on lake biology. Rep. to EPA, Water Pollution Control Res. Ser. 18050-EEC-12/71. Water Resources Res. Center, Indiana Univ., Bloomington. 131 p.

Six coal strip-mine lakes in Pike County, southern Indiana, ranging in pH from 2.5 to 8.2 were studied from July 1969 to December 1970. Results of the sampling program for physical and chemical parameters and for biological parameters are reported. Generally, differences between the lakes indicated successional trends with increasing pH.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R71-36, p. 61).

3A-32 Snyder, R. H. 1947. Effects of coal strip mining on water supplies. J. Am. Water Works Assoc. 39(8):751-756.

3A-33* Vimmerstedt, J. P., and P. H. Struthers. 1968. Influences of time and precipitation on chemical composition of spoil drainage.

(See 1A-21).

3A-34-A Vimmerstedt, J. P., J. H. Finney, and P. Sutton. 1973. Effects of strip mining on water quality. Ohio Agric. Res. Development Center, Wooster, Ohio, Rep. to Ohio State Univ. Water Resources Center, Columbus, Ohio. 54 p. (NTIS PB-217 872).

This report covers two separate topics, the effect of strip-mining on water quality of Little Mill Creek, Ohio and infiltration of water on strip-mine spoil banks. Four sampling points were selected and used over a 236-week period. Results showed that manganese concentrations near the mining area exceeded standards 80 percent of the time while this same chemical in the creek not affected by mining exceeded standards only 13 percent of the time. Sulfate, magnesium, calcium, iron, aluminum, and hydrogen ion concentration were also monitored and found to have higher values in streamflow affected by strip mining. Objective of the second phase was to measure infiltration rates on spoil banks and to identify spoil characteristics associated with these variations in rates. Rates were higher on dry spoil than on wet spoil during the first 25 of the test runs, but later they were similar.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-155, p. 110).

3A-35 Walsh, F. M. 1970. An ecological approach to acid mine pollution control. Eco-Control, Inc. 21 p.

3A-36 Wentz, D. 1974. Effect of mine drainage on the quality of streams in Colorado, 1971-1972. Colorado Water Res. Circ. No. 21. Colorado Water Conserv. Board, Denver. 117 p.

B. Impact of Strip Mining on the Hydrology of Surface and Underground Aquifers

3B-1-A Ahmad, M. U. 1971. Coal mining and its effect on water quality, p. 13-52. *In* Proceedings of Groundwater Pollution Conference. St. Louis, Mo.

The effects of surface and deep mining on water quality are discussed in depth with conditions of mines in Ohio serving as the main examples.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R71-1, p. 55).

3B-2 Bates, R. C., and W. R. Wayment. 1967. Laboratory studies of factors influencing waterflow in mine backfill. Rep. of Investigations No. 7034. Bur. Mines, USDI, Washington, D.C. 45 p.

3B-3-A Bullard, W. E. 1965. Acid mine drainage pollution control demonstration programs: Use of experimental watersheds, p. 190-198. *In* Proceedings of the 1st Symposium on Representative and Experimental Areas. Budapest, Hungary.

Discusses demonstration project, near Elkins, West Virginia, for small watershed control of acid mine drainage from strip mining.
(From R. K. Honkala. 1974 bibliography. No. 447, p. 44).

3B-4-A Cederstrom, D. J. 1971. Hydrologic effects of strip-mining west of Appalachia. Mining Congr. J. 57:46-50.

Although undesirable side effects can result from strip mining, such operations can also prove hydrologically beneficial. West of Appalachia, strip-mined land can be managed to diminish floods, increase low flow and become a significant source of water.
(From R. K. Honkala. 1974 bibliography. No. 659, p. 65).

3B-5-A Collier, C. R., R. J. Pickering, and J. J. Musser (Eds.). 1970. Influences of strip mining on the hydrologic environment of parts of Beaver Creek Basin, Kentucky, 1955-66. Prof. Pap. No. 427C. U.S. Geological Survey, Washington, D.C. 80 p. (QE 75. No. 427).

In this third report in a series on the environmental effects of strip mining in McCreary County, Kentucky, Cane Branch, a stream acid from mining, is compared to Helton Branch which drains an unmined area. The paper includes separate studies on precipitation and runoff, ground water, water geochemistry, erosion and sedimentation, stream bottom fauna, fish population, microbiology of streams, and tree growth. The most

obvious effects of strip mining were on the chemical composition of the water, sediment characteristics of the stream aquatic biology, and on vegetation. The detailed data collected in the various studies are tabulated.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R70-2, p. 51).

3B-6-A Corbett, D. M. 1965. Water supplied by coal surface mines, Pike County, Indiana. Rep. of Investigations No. 1. Water Resources Res. Center, Indiana Univ., Bloomington. 67 p.

The conclusion from this study is that low flow contribution from cast-overburden is significant. Stream flow readings were taken at more than 150 sites on four occasions between September 16 and November 16, 1964, the driest fall on record. Water quality was not measured.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R65-6, p. 31).

3B-7 Corbett, D. M. 1968. Ground water hydrology pertaining to surface mining for coal in southwestern Indiana, p. 164-189. *In* 2nd Symp. on Coal Mine Drainage Research. Ohio River Valley Water Sanitation Commission, Cincinnati.

3B-8 Corbett, D. M., and A. F. Agnew. 1968. Hydrology of the Busseron Creek watershed, Indiana. Rep. of Investigations No. 2. Water Resources Res. Center, Indiana Univ., Bloomington.

3B-9* Curtis, W. R. 1972. Strip-mining increases flood potential of mountain watersheds.
(See 1C-6-A).

3B-10-A Curtis, W. R. 1973. Effects of strip mining on the hydrology of small mountain watersheds in Appalachia, p. 145-157. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 1. Gordon and Breach, New York, N.Y.

The effects of strip mining on the water resources of small mountain watersheds are being investigated in eastern Kentucky. Six subdrainages have been instrumented to record pre-mining conditions, changes during active mining operations, and the rate of recovery after mining. Stream turbidity and peak flows increase during mining, but on one subdrainage, turbidity returned to near pre-mining condition within about 6 months after mining. Storm runoff durations apparently do not change. Sulfate and magnesium in the streamflow have increased since mining.
(From author's abstract).
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-43, p. 87).

3B-11 Davis, G. 1967. Hydrology of contour strip mines in the Appalachian region of the United States, p. 420-443. *In* Proceedings of International Union of Forestry Research, 14th Congress. Vol. 1. Munich, West Germany. (SD118-1).

3B-12-A Hanna, G. P., Jr. 1964. The relation of water to strip-mine operation. Ohio J. Sci. 64(2):120-124.

The study of Beaver Creek Basin is used to illustrate the effects of strip mining on hydrology and to point out the importance of water handling to control pollution.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R64-11, p. 25).

3B-13-A Hotchkiss, W. R., and J. D. Stoner. 1975. Otter Creek coal reclamation study, p. 317. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 3. Eastern Montana Coll., Billings. (Abstr.).

Ground water studies are being conducted on 2400 acres of land near Ashland, Montana underlain by strippable coal. The coal bed is a major part of the underground aquifer of the area. The direction of seepage from the aquifer has been determined. Wells yield about 4 gal/min; specific gravity is 0.1 gal/min/ft. Transmissibility was low at about 1 ft^3/sec. Pumping water from mines would reduce groundwater flow toward streams.

Major water types from the coal are sodium bicarbonate, sodium sulfate or sodium magnesium sulfate. Dissolved solids range from 1210 to 4090 mg/liter. The water produced from the mine would contain sodium in concentrations large enough to make it unsuitable for irrigating vegetation that might be used to stabilize the mine spoils.

(From author's abstract).

3B-14* Jensen, I. B., and R. L. Hodder. 1975. Effects of surface configuration in water pollution control on semi-arid surface mined lands.

(See 1B-12-A).

3B-15 Kieffer, F. V. 1971. Some notes on the spoil hydrology of the Black Mesa, Arizona, surface coal mine area. Ohio Conserv. Federation, Worthington. (Typewritten).

3B-16* May, R. F., and W. D. Striffler. 1967. Watershed aspects of stabilization and restoration of strip mined areas.

(See 1C-16).

3B-17 Musser, J. J. 1963. Description of physical environment and of strip-mining operations in parts of Beaver Creek Basin, Kentucky. Prof. Pap. No. 427A. U.S. Geol. Surv., Washington, D.C. 25 p.

3B-18 Negruckij, S. F. 1959. The dangers of mine water to forest. Lesn. Khoz. 12(11):79 p.

3B-19 Parsons, J. D. 1956. Factors influencing excessive flows of coal strip mine effluents. Trans. Ill. Acad. Sci. 49:25-33.

3B-20-A Richardson, J. A., and E. F. Greenwood. 1967. Soil moisture tension in relation to the colonization of pit heaps. Proc. Univ. Newcastle Phil. Soc. 1(10):129-136.

Soil moisture tension is considered to be an important factor in controlling the establishment of plants on pit heaps. Experiments showed a clear correlation between the moisture tension of the soil and the location of plant cover on the heaps.
(From British bibliography, unpubl.).

3B-21-A Sternberg, Y. M., and A. F. Agnew. 1968. Hydrology of surface mining: A case study. Water Resources Res. 4(2):363-368.

This paper presents a mathematical model of the hydrology of a strip mined area.
(Abstracted by Sally Ralston).

3B-22* Temple, K. L., and F. Kimble. 1976. Quality of leach water from Montana coal mine spoils.
(See 2B-27-A).

3B-23-A Thames, J. L., R. T. Patten, and E. L. Crompton. 1974. Hydrologic study of a reclaimed surface mined area on the Black Mesa, p. 106-116. *In* Second Research and Applied Technology Symposium on Mined-Land Reclamation. Nat. Coal Assoc./Bitum. Coal Res., Inc., Louisville, Ky.

Two 5 acre watersheds, 3/4 mile apart, one on recontoured mined land and one on undisturbed land, were monitored in this study of water availability and quality in the arid southwest. There was no runoff from rain in the study time reported. However, from about the same amount of snowfall there was much greater runoff from the undisturbed area than from the mined area. Water quality analyses showed that while runoff water from the mined area had a higher content of salts than runoff from the unmined area, it was somewhat similar to local municipal

water supplies and had lower salt content than water used for irrigating cropland and orange groves in the region.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R74-96, p. 133).

3B-24-A Tschantz, B. A., and R. A. Minear. 1975. Impact of coal stripmining on water quality and hydrology in east Tennessee. Rep. No. 47. Water Resources Res. Center, Univ. Tennessee, Knoxville. 52 p. (NTIS PB-251 391/9ST).

Six small watersheds (0.7 to 4.9 sq. mi.) within the New River Basin of the Northern Tennessee Cumberland Mountains have been monitored weekly and simultaneously for water quality between January and September, 1975. Three watersheds were undisturbed by mining activity and served to establish bench mark data. The other three watersheds represented varying stages of coal mining in one watershed to essentially complete stripping three years ago and current deep mining activity in another. Distinct differences are observed where the variables, pH, alkalinity, sulfate, calcium, magnesium, iron manganeses, total solids, and suspended solids among the disturbed watersheds in contrast to the undisturbed watershed stream constituent concentrations were quite uniform from stream to stream and from sample to sample.
(From NTIS).

3B-25-A Van Voast, W. A. 1974. Hydrologic effects of strip coal mining in southeastern Montana. Emphasis: One year of mining near Decker. Bull. 93. Montana Bur. Mines and Geol., Helena. 24 p.

This publication describes the hydrologic effects of strip mining done by the Decker Coal Co. in southeastern Montana. The total water movement into and out of the mine is about 400,000 gals/day. The area depends on this water for stock and domestic uses. It is expected that as mining and reclamation proceed, the water flow will decrease through the area. If the mining cut is completely filled, maximum water-level recoveries will result, but minimum recoveries will occur if the cut is left completely unfilled. Extensive flow rate and chemical data are included.
(Abstracted by Sally Ralston).

3B-26 Van Voast, W. A., and R. B. Hedges. 1974. Hydrology of Western Energy Company's probable mine areas near Colstrip, Montana. Preliminary Rep. Montana Bur. Mines and Geol., Helena.

3B-27-A Van Voast, W. A., R. B. Hedges, and G. K. Pagenkopf. 1975. Hydrologic impacts of coal mine effluents and spoils leachates, p. 289-303. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 3. Eastern Montana Coll., Billings.

The objectives are: (1) to describe the current status of research on the effects of strip-mining on water quality, (2) add perspective to the current knowledge, and (3) define the directions of the research program.

The chemical analyses of water from mined areas in Montana are given. Water in the mine spoils is generally more highly mineralized than from lands undisturbed by mining. The range of dissolved solids and specific conductances for mine water is within the upper limits of the normal range for ground water.

Changes in water levels and pressure surfaces at the active sites of the Decker mine are given. Laboratory simulation techniques requisite for the determination of post-mining hydrology are discussed.

(Abstracted by Sally Ralston).

C. Impact of Strip Mining and/or Sedimentation on the Ecology and Biology of Aquatic Flora and Fauna

3C-1 Allen, K. R. 1960. Effects of land development on stream bottom fauna. Proc. New Zealand Ecol. Soc. 7:20-21.

3C-2-A Bahls, L. L. 1975. Microflora of the Yellowstone River: A progress report, p. 195-198. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 2. Eastern Montana Coll., Billings.

The study was designed to: (1) determine the relative importance of periphyton and phytoplankton communities in the Yellowstone system and their interrelationships, (2) describe the seasonal and longitudinal succession of algal populations in the Yellowstone River, (3) determine the location and nature of the so-called cold/warm water "transition zone," (4) determine the utilization of the algae by filter-feeding fish, forage fish, larval fish and invertebrates, (5) determine the impact of present land and river uses on the periphyton community, and (6) estimate the impact of major water diversions and/or impoundments on primary production.
(Abstracted by Sally Ralston).

3C-3 Baker, R. A., and A. G. Wilshire. 1970. Microbial factor in acid mine drainage formation: A pilot study. Environmental Sci. Technol. 4:401-407.

3C-4 Bell, H. L. 1971. The effect of low pH on the survival and emergence of aquatic insects. Water Res. 5(6):313-320.

3C-5-A Bell, R. 1956. Aquatic and marginal vegetation of strip mine waters in southern Illinois. Trans. Ill. State Acad. Sci. 48:85-91. Also in Wildl. Rev. 86:30. (Abstr.).

This study concerned 52 stripland pools with a pH range of 6.0 to 8.0. Dense growths of pondweed occurred in every pond. Apparently, the ferric oxide precipitates and the negatively charged soil particles keep the pools crystal clear. Densities of the submerged and emergent aquatic vegetation indicated high fertility in the water. Hydrogen ion concentration below 4.0 limited plant growth, and extreme changes in water level were detrimental to willows growth. Other factors discussed are the effect of dissolved oxygen, effect of turbidity, and the age of the pool. Many underwater plants and their reactions to various conditions were discussed.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R56-1, p. 8).

3C-6 Bennett, H. D. 1969. Algae in relation to mine water. Castanea 34:306-328. Also in Eutrophication Abstr. 13:6-7.

3C-7-A Blakeley, J. W. 1969. New life for sick streams. Pa. Angler 38(4):8-10, 46.

Gives hope for Pennsylvania's useless waterways polluted by acid mine drainage.
(From R. K. Honkala. 1974 bibliography. No. 650, p. 64).

3C-8-A Branson, B. A., and D. L. Butch. 1971. Effects of strip mining on small-stream fishes in east central Kentucky. Biol. Soc. Wash. Proc. 84(59):507-517.

The most damaging factors in the area studied was not the acid mine water but the high level of siltation and turbidity originating from intensive erosion of the spoil banks.
(From R. K. Honkala. 1974 bibliography. No. 358).

3C-9 Branson, B. A., and D. L. Butch. 1974. Additional observations on the effects of strip mining on small stream fishes in central Kentucky U.S.A. Trans. Ky. Acad. Sci. 35(3-4):81-83.

3C-10 Burner, C. C., and C. Leist. 1953. A limnological study of the College Farm strip-mined lakes. Trans. Kansas Acad. Sci. 56(1):78-85.

3C-11* Campbell, R. S., and O. T. Lind. 1969. Water quality and aging of strip mine lakes.
(See 3A-6).

3C-12 Campbell, R. S., et al. 1965. Water pollution studies in acid strip mined lakes: Changes in water quality and community structure associated with aging, p. 188-196. *In* Symposium on Acid Mine Drainage. Pittsburgh, Pa.

3C-13 Chutter, F. M. 1969. The effects of silt and sand on the invertebrates fauna of streams and rivers. Hydrobiologie 34:57-76.

3C-14-A Coe, M. W., and D. V. Schmelz. 1972. A preliminary description of the physico-chemical characteristics and biota of three strip mine lakes, Spencer County, Indiana. Proc. Ind. Acad. Sci. 82:184-188.

Three Spencer County strip mine lakes in the same immediate area, each about 30 years old, were studied. Differences between the characteristics of the lakes are a function of area/volume ratios, slopes of basins, and watersheds. These lakes are in the alkaline stage of recovery. The study results prove that each lake is modified, chemically, physically, and biotically, at its own rate.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R72-8, p. 65).

3C-15* Collier, C. R., et al. (Eds.). 1970. Influences of strip mining on the hydrologic environment of parts of Beaver Creek Basin, Kentucky, 1955-66.
(See 3B-5-A).

3C-16 Cooper, E. C. 1966. Fish distribution in relation to acid mine drainage. Contract 14-16-0005-2091. U.S. Bur. Sport Fisheries and Wildl. and Pennsylvania State Univ., University Park.

3C-17-A Cordone, A. J., and D. Kelley. 1961. The influence of inorganic sediment on the aquatic life of streams. Calif. Fish Game 47(2):189-228.

This paper is an extensive review of investigations made on the effects of inorganic sediments on the aquatic life of streams prior to 1961. Chapters deal with the effect of sediment on: fishes; eggs and alevins; bottom organisms (and their importance to the stream biosystem); aquatic plants; chemical and physical characteristics of the stream; and fish habitats and populations. Sediment standards and long-term siltation research are also discussed.
(Abstracted by Sally Ralston).

3C-18 Crawford, B. T. 1942. Ecological succession of strip-mine lakes in Missouri. M.S. Thesis. Univ. Missouri, Columbia.

3C-19 Davis, R. M. 1971. Limnology of a strip mine pond in western Maryland. Chesapeake Sci. 12(2):111-114.

3C-20 Dean, J. M. 1963. A quantitative evaluation of pollution effects on stream communities. Hydrobiologia 21:193.

3C-21 Dinsmore, B. H. 1958. Ecological studies of twelve strip mine ponds in Clarion County, Pa. Ph.D. Diss. Univ. Pittsburgh, Pa. Also in Diss. Abstr. 19(1958):1479-1480.

3C-22* Ellis, M. M. 1936. Erosion silt as a factor in aquatic environments.
(See 1C-9).

3C-23-A Elser, A. A. 1975. Fish distribution and diversity of a Montana prairie stream, p. 124-137. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 2. Eastern Montana Coll., Billings.

Fish populations of the Tongue River were sampled to determine species composition, distribution, and diversity for various habitat zones of this prairie stream. Electrofishing gear, baited hoop nets and traps, a beach seine and large meshed gill-nets were utilized to sample the fish populations in six primary and five secondary sampling sections. Twenty-nine species of fish were collected from the Tongue River during 1974 of which three (burbot, shovelnose sturgeon and blue sucker) were considered migrant. Six species ranged the length of the stream. Irrigation diversion structures influenced longitudinal distribution of fish in the Tongue River. Sucker distribution grades from predominately longnose immediately downstream from the Tongue River Dam to white suckers in mid-reaches, with shorthead redhorse dominance downstream. Smallmouth bass, sauger and channel catfish were the dominant sport fish. Species diversity indices were calculated, showing a general increase with downstream progression, indicating an increase of rarer species in the lower reaches. A total of 1,060 fish were tagged in the river with a total angler return rate of 1.51 percent, suggesting an under utilized fishery resource. (From author's abstract).

3C-24-A Elser, A. A. 1976. Impact of coal development on the aquatic biota of Rosebud Creek, Montana, p. 13-25. In R. V. Thurston, R. K. Skogerboe, and R. C. Russo (eds.) Quarterly progress report--October-December 1975: Toxic effects on the aquatic biota from coal and oil shale development. EPA Internal Progress Rep. No. 5. Colorado State Univ., Fort Collins.

A study of the distribution of fishes and macroinvertebrates in Rosebud Creek is continuing. Fish collections have been made by electrofishing eight established sampling stations, and a total of sixteen species have been identified. Samples have been preserved for tissue analysis at Montana State University for trace metals. Invertebrate collections have been made at four stations and species identification has begun. Distribution data will be available soon. (From author's abstract).

3C-25 Fox, A. C. 1971. Development and impoundment of drastically disturbed surface mined land for fishing, p. 109-111. In Symposium on rehabilitation of drastically disturbed surface mined land. Georgia Surface Mined Land Use Board, Macon, Ga., 4-5 November.

3C-26 Gammon, J. 1970. The effect of inorganic sediment on stream biota. Water Pollution Control Ser. Water Quality Office, EPA, Washington, D.C. 141 p.

3C-27 Gash, S. L. 1968. Limnology and fisheries production of acid and alkaline strip mine lakes. M.S. Thesis. Kansas State College of Pittsburgh, Kansas.

3C-28 Geiling, W. T. 1970. Zooplankton production in a series of strip mine lakes. Ph.D. Diss. Univ. Missouri, Columbia. Also in Diss. Abstr. 30(8):3919-3920B.

3C-29-A Gore, J. A. 1975. Fall-winter composition of the benthic macroinvertebrates of the Tongue River, Montana, p. 212-225. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 2. Eastern Montana Coll., Billings.

An inventory is presented of the benthic macroinvertebrates of a river considered to be typical of the Fort Union coal region. The habitat requirements of various species and genera are discussed with reference to the possible impact of changes in hydrology of the river.
(Abstracted by Sally Ralston).

3C-30-A Gregory, R. W., and R. F. Penkal. 1976. Predicted impact of coal development on the fishery resources of the Tongue River Reservoir, Montana, p. 47-57. *In* R. V. Thurston, R. K. Skogerboe, and R. C. Russo (eds.) Quarterly progress report--October-December: Toxic effects on the aquatic biota from coal and oil shale development. EPA Internal Progress Rep. No. 5. Colorado State Univ., Fort Collins.

A study continues on the Tongue River Reservoir to determine the possible impacts from an adjacent coal strip mine operation on the sport fishes. Population analysis of the 1975 fish creel census data has been started. Analysis of rates of black bass continues.
(From author's abstract).

3C-31 Hagen, R. M., and E. R. Roberts. 1973. Ecological impacts of water storage and diversion projects. *In* C. R. Goldman, J. McEvoy III, and P. J. Richardson (eds.) Environmental quality and water development. W. H. Freeman & Co., San Francisco, Calif.

3C-32 Harp, G. L. 1969. Dynamics of the benthic macroinvertebrates communities in a series of strip mine lakes of different pH. Ph.D. Diss. Univ. Missouri, Columbia. Also in Diss. Abstr. B 30(9):4426-4427.

3C-33 Heaton, J. R. 1951. The ecology and succession of a group of acid and alkaline strip mine lakes in central Missouri. M.S. Thesis. Univ. Missouri, Columbia.

3C-34 Johnson, R. E. 1951. Characteristics of strip mine lakes and their fishery management potential. Fish and Wildlife Serv., USDI, Washington, D.C.

3C-35-A King, D. L., J. J. Simmler, C. S. Decker, and C. W. Ogg. 1974. Acid strip mine lake recovery. J. Water Pollut. Control Fed. 46(10):2301-2315.

Discussion of the roles of aluminum and organic matter in the neutralization of strip mine lakes.

Methods for controlling the numbers of sulfate reducing bacteria are also covered.
(Abstracted by Sally Ralston).

3C-36 Kinney, E. C. 1964. Extent of acid mine pollution in the United States affecting fish and wildlife. Circ. 191. U.S. Bur. Sport Fisheries and Wildl., Washington, D.C. 27 p.

3C-37 Koryak, M., M. Shapiro, and J. Sykora. 1972. Riffle zoobenthos in streams receiving acid mine drainage. Water Res. 16:1239-1249.

3C-38 Kralovic, R. C., and H. A. Wilson. 1969. Survival and activity of sewage microorganisms in acid mine water. Water Res. Inst., Univ. West Virginia, Morgantown.

3C-39 Lackey, J. B. 1938. The flora and fauna of surface waters polluted by acid mine drainage. Public Health Rep. 53:1499-1507.

3C-40-A Lackey, J. B. 1939. Aquatic life in waters polluted by acid mine water. Public Health Rep. 54:740-746.

Two coal mining regions were visited and two biological surveys made of their highly acid streams and strip pit lakes. A few adjacent almost neutral streams and lakes were surveyed for comparison.

A total of 86 species of microscopic forms were recognized. Only Thallophyta, protozoans, trochelminthes, and arthropods were represented by more than one commonly occurring species in the acid waters. At or below pH 3.9 the number of species found in any given habitat was very small.

(From author's abstract).

3C-41-A Lewis, W. M., and J. Nicknum. 1964. Rearing trout in raceways supplied by water from the hypolimnion of a strip mine pond. Prog. Fish-Cult. 26:27-32.

We believe the potentials of these ponds as a water supply for hatchery and rearing units should receive attention.

(From author's abstract).

3C-42* Lewis, W. M., and C. Peters. 1955. Physico-chemical characteristics of ponds in the Pyatt, Desoto, and Elkville strip mined areas of southern Illinois.
(See 3A-18).

3C-43 Lind, O. T., and R. S. Campbell. 1970. Community metabolism in acid and alkaline strip mine lakes. Trans. Am. Fish. Soc. 99(3):577-582.

3C-44 Maupin, J. K., et al. 1954. A preliminary survey of food habits of the fish and the physio-chemical conditions of the water of three strip mine lakes. Trans. Kansas Acad. Sci. 57:164-171.

3C-45-A McFeters, G., S. Turbak, and G. Olson. 1976. Effects of coal mining and conversion on aquatic microflora, p. 59-71. *In* R. V. Thurston, R. K. Skogerboe, and R. C. Russo (eds.) Quarterly progress report--October-December 1975: Toxic effects on the aquatic biota from coal and oil shale development. EPA Internal Project Rep. No. 5. Colorado State Univ., Fort Collins.

Selected bacterial populations (aerobic heterotrophs and organisms functional in the nitrogen cycle) were enumerated in water and sediment samples from four Rosebud Creek sites. Water and sediment from the Decker mine settling pond were also sampled for populations of bacteria capable of activity in the nitrogen cycle and sulfur cycle. In both the Rosebud and the Decker samples, the numbers of organisms in the sediment were generally two orders of magnitude higher than those in the overlying water column. Artificial substrates placed in the Rosebud Creek to study the periphyton did not show measurable development of this community after four weeks.

Results of algal assay bottle tests on Rosebud Creek waters and mine discharge from Decker suggest that both nitrogen and phosphorus were limiting to the growth of test alga. No evidence was found for the presence of toxic concentrations of heavy metals of limiting concentrations of trace metals in these waters.
(Abstracted by author).

3C-46 Moffet, J. W. 1936. A quantitative study of the bottom fauna in some Utah streams variously affected by erosion. Bull. Univ. Utah 26(9):1-32.

3C-47 Nash, H. D. 1970. The effects of strip mining on the microbiology of a stream free from domestic pollution. Ph.D. Diss. Univ. Kentucky, Lexington. Also in Diss. Abstr. 30(8):3783B.

3C-48-A R. R. Nathan Associates, Inc. 1969. Mine drainage pollution and recreation in Appalachia, p. 1-114. *In* Acid mine drainage in Appalachia: Impact of mine drainage on recreation and stream ecology (Appendix E and F). Appalachian Regional Comm., Washington, D.C.

Abatement of mine acid drainage enhances scenery especially in the case of surface mining operations. Restores areas lost to water-based recreational activity.
(From R. K. Honkala. 1974 bibliography. No. 764, p. 74).

3C-49 Nuttall, P. M. 1972. The effects of sand deposition upon the macroinvertebrate fauna of the River Camel, Cornwall. Freshwater Biol. 2:181-186.

3C-50 Nuttall, P. M., and G. M. Bielby. 1973. The effects of china-clay wastes on stream invertebrates. Environ. Pollut. 5(2):77-86.

3C-51-A Olsen, R. A., and G. Warren. 1976. Aquatic pollution potential of fly ash particles, p. 91-96. *In* R. V. Thurston, R. K. Skogerboe, and R. C. Russo (eds.) Quarterly progress report--October-December 1975: Toxic effects on aquatic biota from coal and oil shale development. EPA Internal Project Rep. No. 5. Colorado State Univ., Fort Collins.

Aqueous extracts from coal fly ash and the fly ash itself have been tested for toxicity to algae. The aqueous extracts, which were high in calcium but relatively low in most heavy metals were not appreciably toxic to the algal organisms used. The particulate ash material itself caused a marked decrease in or complete inhibition of cell growth.

(Abstracted by author).

3C-52 Parsons, J. D. 1956. The effects of acid strip mine pollution on the ecology of a central Missouri stream. Ph.D. Diss. Univ. Missouri, Columbia. Also in Diss. Abstr. 16(1956):1301-1302.

3C-53-A Parsons, J. D. 1964. Comparative limnology of strip-mine lakes. Int. Ver. Theor. Angew. Limnol. Verh. 15:293-298.

Six strip-mine lakes in Missouri were characterized. Three were classified as Type I - Red Lakes, chemically the youngest, with high acid and iron content; and three were classified as Type III - Blue Lakes, which are chemically older and had low iron concentration, lacked turbidity, and were homothermous year round. These six lakes were compared to Type II Lakes, transitional between Types I and III, and to Type IV Lakes, chemically the oldest, with least iron and acidity and measurable alkalinity.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R64-26, p. 28).

3C-54 Parsons, J. D. 1968. The effects of acid strip mine effluents on the ecology of a stream. Arch. Hydrobiol. 65(1):25-50.

3C-55 Parsons, J. W. 1951. A biological approach to the study and control of acid mine pollution. Presented at the Southeastern Assoc. of Game and Fish Commissioners. 21-24 October, Edgewater Park, Miss. (Mimeo).

3C-56 Peters, J. C. 1965. The effects of stream sedimentation on trout embryo survival, p. 275-279. *In* Biological problems of water pollution: 34th seminar, 1962. Public Health Service Publ. 999-WP-25. HEW, Washington, D.C.

3C-57 Peters, J. C. 1967. Effects on a trout stream of sediment from agricultural practices. J. Wildl. Manage. 31(4): 805-812.

3C-58 Reger, S. 1973. Benthic macroinvertebrate diversity in three differentially perturbed Michigan streams. Dep. Fish Wildl., Michigan State Univ., East Lansing. 60 p.

3C-59-A Riley, C. V. 1960. The ecology of water areas associated with coal strip-mined lands in Ohio. Ohio J. Sci. 60(2): 106-121.

This paper deals with the effects of coal strip mining operations on the pH and fertility of lake water. It contains a survey of the aquatic flora and fauna of lakes associated with strip mined lands. (Abstracted by Sally Ralston).

3C-60 Riley, C. V. 1965. Limnology of acid mine impoundments, p. 175-187. *In* 1st Symp. on Acid Mine Drainage Research, Pittsburgh, Pa. Ohio River Valley Water Sanitation Commission, Cincinnati.

3C-61 Ritchie, J. C. 1972. Sediment, fish and fish habitat. J. Soil Water Conserv. 27(3):124-125.

3C-62 Ruhr, C. E. 1952. Fish population of a mining pit lake, Marion County, Iowa. Iowa State J. Sci. 27(3):55-77.

3C-63 Sanders, J. W., and M. W. Smith. 1965. Changes in a stream population associated with increased silt. J. Fish. Res. Board Can. 22(2):395-404.

3C-64-A Savage, N. L., and F. W. Rabe. 1973. The effects of mine and domestic wastes on the macroinvertebrate community structure in the Coeur d'Alene River. Northwest Sci. 47(3): 159-168.

The objectives are to determine the effect of reduction in tailings discharge on the benthic community composition. It entailed examination of unaltered sections of the river for control purposes and monitoring of the test stations before and after impoundment. (Abstracted by Sally Ralston).

3C-65 Shapley, S. P., and D. M. Bishop. 1965. Sedimentation in a salmon stream. J. Fish. Res. Board Can. 22(4):919-928.

3C-66 Sheldon, R. W., and P. J. Warren. 1966. Transport of sediment by crustaceans and fish. Nature 210(5041):1171-1172.

3C-67 Shelton, J. M., and R. D. Pollock. 1966. Siltation and egg survival in incubation channels. Trans. Am. Fish Soc. 95(2):183-187.

3C-68* Smith, R. W., and D. G. Frey. 1971. Acid mine pollution effects on lake biology.
(See 3A-31-A).

3C-69-A Spaulding, W. M., Jr., and R. D. Ogden. 1968. Effects of surface mining on the fish and wildlife resources of the United States. Resources Publ. No. 68. Bur. Sport Fisheries and Wildl. and Fish and Wildl. Serv., USDI. U.S. Government Printing Office, Washington, D.C.

The report is in conjunction with the Appalachian Regional Development Act of 1965, Public Law 89-4, Section 205. An interagency field appraisal team of specialists from seven Federal agencies observed the effects of surface mining on natural resources. It reported that 3.2 million acres have been surface mined, 95% of which was disturbed during the recovery of coal, sand and gravel, gold, phosphate, iron, and clay. The report also disclosed that approximately 2 million acres of fish and wildlife habitat have been damaged and stresses the need for reclamation of the disturbed lands as well as proper legislation to handle future reclamation problems resulting from surface mining.
(From Dalsted and Leistritz. 1973 bibliography. No. H-35, p. 36).

3C-70 Stockinger, N. F., and H. A. Hays. 1960. Plankton benthos and fish in three stripmine lakes with varying pH values. Trans. Kansas Acad. Sci. 63(1):1-11.

3C-71 Tabita, R., M. Kaplan, and D. Lundgren. 1970. Microbial ecology of alkaline mine drainage, p. 94-113. *In* Proc. Third Symp. Coal Mine Drainage Research, Pittsburgh, Pa.

3C-72-A Thorp, V. J., and P. S. Lake. 1973. Pollution of a Tasmanian river by mine effluents. II. Distribution of macroinvertebrates. Int. Rev. Gesamten Hydrobiol. 58(6):885-892.

The distribution and abundance of macroinvertebrates were studied in the South Esk River, Tasmania; a river subject to cadmium and zinc pollution as a result of mining. The groups most intolerant of cadmium-zinc pollution were the Crustacea, Mollusca and Annelida. Highly tolerant groups included aquatic Hemiptera and Arachnida and the larvae of leptocerid trichopterans. A

drop in both species diversity and abundance occurred after floods in winter and was probably due to pulses of cadmium and zinc down the river and also due to increased molar action of the unstable substrate.
(Abstracted by Sally Ralston).

3C-73-A Thurston, R. V., and R. C. Russo. 1976. Fisheries Bioassay Laboratory field and laboratory studies, p. 137-154. *In* R. V. Thurston, R. K. Skogerboe, and R. C. Russo (eds.) Quarterly Progress Report--October-December 1975: Toxic effects on the aquatic biota from coal and oil shale development. EPA Internal Project Rep. No. 5. Colorado State
Univ., Fort Collins.

Research has been started on the examination of fish tissues for the accumulation of trace metals which may result from coal extraction and/or conversion. Results are not yet definitive at this time.

Bioassays on potential toxicants from coal and oil shale mining have also been started. Various toxicants have been tested on the fat head minnow. Preliminary results are reported.
(Abstracted by author).

3C-74* Tobaben, D. J. 1969. Limnology of strip mine lakes and chemical analysis of spoil materials.
(See 2A-79).

3C-75-A Turner, W. R. 1958. The effects of acid mine drainage on the fish population of Goose Creek, Clay County, Kentucky. Prog. Fish-Cult. 20:45-46.

Goose Creek was polluted on April 2, 1957 by acid waters from an operating coal mine; 16.3 miles of the stream were reportedly polluted, effecting a fish kill over the same area. The total poundage of fish in the area above the polluted segment was nearly twelve times as great as the total poundage of fish in the polluted area. The estimated creel value of the fish destroyed was $2,212 for game fish and $9,268 for pan fish. Total economic loss was estimated at $13,325.
(Abstracted by author).

3C-76 Tuttle, J. H., H. Randles, and P. K. Dugan. 1968. Activity of microorganisms in acid mine water on aerobic heterotrophs of a normal stream. J. Bacteriol. 95(5):1495-1503.

3C-77-A Tyler, P. A., and R. T. Buckney. 1973. Pollution of a Tasmanian river by mine effluents. I. Chemical evidence. Int. Rev. Gesamten Hydrobiol. 58(6):873-883.

Discharge of effluents from tin and wolfram mines has caused severe pollution of two creeks and lesser pollution of the South Esk River in northeast Tasmania. The principal pollutants are sulphuric acid, zinc, cadmium, copper, lead, iron, and manganese in dissolved or particulate form or both. The creek waters are rendered unsuitable for domestic or agricultural use and all normal biota are destroyed. In the South Esk River trout are absent from polluted reaches though abundant elsewhere. Flood-borne mine tailings, rich in particulate pollutants, have destroyed or degraded pastures along the South Esk River.

(Abstracted by Sally Ralston).

3C-78 Wallen, I. E. 1951. The direct effect of turbidity on fishes. Bull. Okla. Agric. Mech. Coll., Biol. Ser. 48(2):1-27.

3C-79-A Ward, J. V. 1974. A temperature stressed stream ecosystem below a hypolimnal release mountain reservoir. Arch. Hydrobiol. 74(2):247-275.

Biological, chemical and physical parameters were measured over a 12-month period at four sampling sites on the South Platte River below a Colorado reservoir. Owing to the hypolimnal source, the stream temperature was higher than normal in winter, lower in summer, fluctuated less diurnally and seasonally, and exhibited a seasonally displaced maximum. These effects decreased downstream, but still altered the temperature pattern 8.5 km below the dam. The number of species of macroinvertebrates progressively increased downstream, and it is thought that the temperature regime is responsible for the low diversity by failing to stimulate various developmental stages of the life cycle or by seasonally altering the developmental processes. It is felt that the river below the dam is a temperature stressed ecosystem, and that is the major reason for the low diversity and large standing crop of macroinvertebrates.

(Abstracted by Sally Ralston).

3C-80-A Ward, J. V., and S. Canton. 1976. Effects of coal mine drainage on the macroinvertebrates of Trout Creek, Colorado, p. 179-195. *In* R. V. Thurston, R. K. Skogerboe, and R. C. Russo (eds.) Quarterly progress report--October-December 1975: Toxic effects on the aquatic biota from coal and oil shale development. EPA Internal Project Rep. No. 5. Colorado State Univ., Fort Collins.

A study continues on the macroinvertebrate distribution in Trout Creek relative to the Edna Coal mine. Results of sample collections for August, September, and November are presented. The general downstream increase in macroinvertebrates standing crop seems to indicate an enrichment effect downstream. Not all data, however, conform to the normal pattern for nutrient enrichment. (Abstracted by author).

3C-81 Warner, R. W. 1971. Distribution of biota in a stream polluted by acid mine drainage. Ohio J. Sci. 71(4):202-215.

3C-82 Whitney, A. N., and J. E. Bailey. 1959. Detrimental effects of highway construction on a Montana stream. Trans. Am. Fish. Soc. 88:72-73.

D. Mining Requirements for Water

3D-1 Agnew, A. F. 1966. A quarter to zero, surface mining and water supplies. Mining Congr. J. 52(10):29, 32-34, 38-40.

3D-2 Anderson, B. 1973. Water and eastern Montana coal development. Second Annu. Rep., Montana Environmental Quality Council. Helena, Mont.

3D-3 Anderson, M. W., et al. 1973. The demand for agricultural water in Utah. Utah Water Res. Lab., Utah State Univ., Logan.

3D-4 Davis, G. H., and L. A. Wood. 1974. Water demand for expanding energy development. U.S. Geol. Surv. Circ. 703. U.S. Geol. Surv., USDI, Reston, Va.

3D-5 Dexter, G. M. 1949. Municipal water needs vs. strip coal mining. Trans. Am. Inst. Mining Metallurgical Eng. 184:137-185.

3D-6-A Gibbs, P. W. 1975. Availability of water for future uses, p. 10-17. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 1. Eastern Montana Coll., Billings.

Six major water sources for the Fort Union-Powder Basin Coal region are examined in detail, with respect to the amount of water available, current usage, and the areas the respective sources might serve. The sources discussed are: (1) the Bighorn River at or below Bighorn Lake, (2) Yellowstone River near Miles City, Montana, (3) Fort Peck Reservoir, (4) Lake Sakakawea, (5) Oahe Reservoir, and (6) Green River near Rock Springs.
(Abstracted by Sally Ralston).

3D-7-A Krueger, R. W. 1975. Availability of water for energy uses, p. 8-9. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 1. Eastern Montana Coll., Billings.

The author claims coal to be the immediate answer to the current energy problems. The need for water to develop the Great Plains coal reserves is a primary concern to all those involved in such development, either directly or indirectly. An outline of the Bureau of Reclamation's past, present, and future programs dealing with the management of existing water resources for the maximum good of all those concerned is presented in this paper.
(Abstracted by Sally Ralston).

3D-8-A Persse, F. H., and D. G. Willard. 1972. Projected water requirements of new mineral industry research in Powder River Basin, Montana and Wyoming. Preliminary Rep. No. 187. Bur. Mines, USDI, Washington, D.C.

This study indicates that coal will be the basic mineral for new industry in the Powder River Basin of Montana and Wyoming. Coal will be used in increasing quantities for generating electric power and, if competitive processes are demonstrated, for conversion to synthetic liquid fuels and pipeline gas. Energy market analyses and projections indicate that by the year 2020 as much as 674 million tons of coal annually could be mined in the 12-county area for use both within and outside the Powder River Basin. Industrial utilization of coal in these magnitudes would require large amounts of water, as much as 2.2 million acre-feet annually.

(From Dalsted and Leistritz. 1973 bibliography. No. H-31, p. 35).

3D-9 Polzin, P. E. 1974. Water use and coal development in eastern Montana. Montana State Univ. Joint Water Resources Research Center. Montana State Univ., Bozeman.

3D-10 Thomas, J. L. 1975. Water requirements and wastewater potential of coal-energy facilities, p. 179-190. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 2. Eastern Montana Coll., Billings.

3D-11 Western States Water Council. 1974. Western states water requirements for energy development to 1990. Western States Water Council. Salt Lake City, Utah.

E. General Aquatic Ecology and Hydrology

3E-1-A Anderson, B. 1975. A study of the impacts of reduced streamflows in the Middle and Lower Yellowstone Basin, p. 226-232. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 2. Eastern Montana Coll., Billings.

A description of the studies being implemented to evaluate the social, economic and environmental impacts of reduced stream flow in the middle and lower Yellowstone Basin. These studies were due to be completed June 30, 1976.

Subobjectives were listed as follows:

(1) To refine, calibrate and evaluate surface water flow models for the region,
(2) To acquire data relating surface flow parameters to impacts on selected water uses,
(3) To quantify the economic values and costs of various degrees of water consumption.

(Abstracted by Sally Ralston).

3E-2 Bergessen, E. P., and W. J. Melonnell. 1973. Pollution investigations on the Yellowstone River, Yellowstone National Park, Wyoming. Colorado Div. of Wildl. and Colorado State Univ., Fort Collins. 140 p.

3E-3-A Bickel, D. 1975. Computerized data file of Rocky Mountain and Northern Great Plains mollusks for endangered species surveys and environmental analysis: A preliminary report, p. 191-194. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 2. Eastern Montana Coll., Billings.

The data file, not completed at the time of this paper, will provide a regional faunal review of mollusks that is far more flexible than the traditional summaries. (Abstracted by Sally Ralston).

3E-4 Birot, Y., and J. Galabert. 1970. Water economy and soil working in a dry zone 1969-1970: Application to the Sahelian-Sudanese region. Bois For. Trop. 127:29-44, 128:23-37, 129:3-20, 130:12-22. (In French).

3E-5-A Bovee, K. 1975. Assessment and implementation of "in-stream value studies" for the Northern Great Plains, p. 112-123. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 2. Eastern Montana Coll., Billings.

A method for determining minimum stream flow requirements is described. Criteria are based on the minimum stream flow that allows "indicator" species of fish to spawn successfully. A computer program has been developed to analyze hydrologic maps in concert with the fish criteria to determine the critical discharge levels for streams.

Critical discharge criteria are given for three species of fish: Sauger, paddlefish and stonecats. Important physical parameters which also affect stream flow are discussed. The author states that more work is needed on (1) ice formation in streams and (2) more data on the critical discharge levels for sauger and other possible "indicator" species.

(Abstracted by Sally Ralston).

3E-6 Brant, R. A., and E. Q. Moulton. 1960. Acid mine drainage manual. Ohio State Univ. Eng. Exp. Sta. Bull. 179. Ohio State Univ., Columbus.

3E-7* Brooks, R. H., and A. T. Corey. 1966. Properties of porous media affecting fluid flow.
(See 2A-13).

3E-8 Burner, C., and R. Schoonover. 1953. Progress report on strip mine lake investigations, 1953. Kansas Forestry, Fish and Game Comm. Topeka, Kansas. (Mimeo).

3E-9 Cecil, L. K. 1967. Municipal water from western rivers: Water quality criteria. Special Tech. Bull. 416, p. 5-12. Am. Soc. Testing and Material, Philadelphia, Pa.

3E-10 Cummins, K. W., and G. H. Lauff. 1969. The influence of substrate particle size on the microdistribution of stream macro-benthos. Hydrobiologie 34:145-181.

3E-11 Cummins, K. W., C. A. Tryon, and R. T. Hartman (Eds.). 1964. Organism-substrate relationships in streams. Special Publ. No. 4. Pymatuning Laboratory, Univ. Pittsburgh, Pa. 145 p.

3E-12 Cushing, C. E., and D. G. Watson. 1968. Accumulation of ^{32}P and ^{65}Zn by living and killed plankton. Oikos 19:143-145.

3E-13* Elser, A. A. 1975. Fish distribution and diversity of a Montana prairie stream.
(See 3C-23-A).

3E-14 Feltis, R. D. 1973. Geology and water resources of the eastern part of Judith Basin, Montana. Montana Bur. Mines and Geol. Bull. 87. Helena. 57 p.

3E-15 Gibbons, J. W., and R. R. Sharitz. 1974. Thermal alteration of aquatic ecosystems. Am. Sci. 62:660-670.

3E-16-A Goettl, J. P., Jr., and J. Edde. 1976. Fish distribution in Trout Creek and Piceance Creek, Colorado, p. 31-45. *In* R. V. Thurston, R. K. Skogerboe, and R. C. Russo (eds.) Quarterly progress report--October-December 1975: Toxic effects on aquatic biota from coal and oil shale development. EPA Internal Project Rep. No. 5. Colorado State Univ., Fort Collins.

A study continues on the fish distribution in Trout Creek relative to the Edna Coal Mine. Activities this quarter included recovery and analysis of rainbow trout stocked in ponds at the Edna Mine site and electrofishing at four stations on Trout Creek. A pattern for permanent and nonpermanent populations is beginning to develop. (From author's abstract).

3E-17 Hadley, D. F., and S. A. Schumm. 1961. Sediment sourness and drainage basin characteristics in Upper Cheyenne River Basin. Water Supply Paper 1531-B:137-195. U.S. Geol. Surv., USDI, Washington, D.C.

3E-18 Halliburton Company. 1970. Investigative mine survey of a small watershed. Water Pollution Control Ser. U.S. Federal Water Quality Administration, Cincinnati, Ohio.

3E-19 Hartke, E. J. A preliminary report on acid mine drainage in the Monday Creek Drainage Basin. Dep. Geology, Ohio State Univ., Columbus. (Mimeo).

3E-20 Haupt, H. F. 1967. Infiltration, overland flow, and soil movement on frozen and snow-covered plots. Water Resources Res. 3(1):145-161.

3E-21-A Herricks, E. E., and J. Cairns, Jr. 1972. The recovery of stream macrobenthic communities from the effects of acid mine drainage. Presented at 4th Symposium on Coal Mine Drainage Research, April 26-27. Mellon Inst., Pittsburgh, Pa.

Under the conditions of constant acid mine drainage, recovery of downstream aquatic communities is not as rapid as had been previously reported. Both biological and chemical effects of acid drainage in Indian Creek vary with season depending on acid drainage-stream volume relationships between the acid source and receiving stream. The effects of acid drainage on water quality include a decrease in pH, an increase in sulfate and iron, and an increase in the acidity/alkalinity ratio. The effects on aquatic communities include a reduction in diversity and density, and dominance by tolerant organisms. Recovery was evidenced by establishment of communities with a large number of species, most of which were represented by relatively few individuals. Tributaries

improve water quality by dilution and supply organisms to re-invade the damaged regions of the stream.
(From author's abstract).

3E-22 Hooper, D. R. 1973. Evaluation of the effects of flows on trout stream ecology. Dep. of Engineering Research, Pacific Gas and Electric Co., Emeryville, Calif. 97 p.

3E-23 Houston, W. R. 1960. Effects of water spreading on range vegetation in eastern Montana. J. Range Manage. 13:289-293.

3E-24 Hubbs, C. 1972. Some thermal consequences of environmental manipulation of water. Biol. Conserv. 4(3):185-188.

3E-25 Hynes, H. B. N. 1963. The biology of polluted waters. Liverpool Univ. Press, Liverpool, England. 214 p.

3E-26 Jewell, M. E. 1922. The fauna of an acid stream. Ecology 3(1):22-28.

3E-27-A Jones, S. L. 1965. Stream pollution control in the upper Cumberland River Basin. Stream Pollution Control Div., Dep. Public Health, Nashville, Tenn. 37 p.

Reference is made to problems created by shaft and strip mining in the summary.
(From R. K. Honkala. 1974 bibliography. No. 477, p. 47).

3E-28 Katz, M. 1969. The biological and ecological effects of acid mine drainage with particular emphasis on the waters of the Appalachian Region, 65 p. *In* Acid mine drainage in Appalachia: Impact of mine drainage on recreation and stream ecology (Appendix E and F). Appalachian Regional Comm., Washington, D.C.

3E-29* Keys, J. W., III, J. F. Ruff, and M. M. Skinner. 1975. A remote sensing study of sediment in the Clarks Fork, Yellowstone River.
(See 1C-15-A).

3E-30 Krishna, D. 1953. Effect of changing pH on developing trout eggs and larvae. Nature 171:434.

3E-31 Lackey, J. B. 1938. A study of some ecological factors affecting the distribution of protozoa. Ecol. Monogr. 8(4):501-527.

3E-32 Lemkuhl, D. M. 1972. Changes in thermal regime as a cause of reduction of benthic fauna downstream of a reservoir. J. Fish. Res. Board Can. 29:1329-1332.

3E-33 Lloyd, R., and D. M. R. Jordan. 1964. Some factors affecting the resistance of rainbow trout (*Salmo gairdnerii richardson*) to acid waters. Int. J. Air Water Pollut. 8:393-340.

3E-34 Love, S. K. 1961. Relationship of impoundment to water quality. J. Am. Water Works Assoc. 53:559-568.

3E-35 McGuinness, C. L. 1963. The role of groundwater in the national water situation. U.S. Geol. Surv. WSP-1800. USDI, Washington, D.C. 1120 p.

3E-36 McMurtrey, R. G., and T. E. Reich. 1967. Water levels and artesian pressures in observation wells in Montana. U.S. Geol. Surv., USDI, Washington, D.C.

3E-37 National Technical Advisory Committee. 1968. Water quality criteria. Federal Water Pollution Control Administration, Washington, D.C.

3E-38 Northern Great Plains Resources Program. 1974. Shallow groundwater in selected areas in the Fort Union coal region. Open File Rep. 74-371. Groundwater Subgroup, U.S. Geol. Surv., Helena, Mont.

3E-39 Peterson, H. V. 1962. Hydrology of small watersheds in western states. Water Supply Paper 1475-1:217-356. U.S. Geol. Surv., USDI, Washington, D.C.

3E-40 Powers, E. B. 1930. The relationship between pH and aquatic animals. Am. Nat. 64:342-366.

3E-41 Roeder, T. S. 1966. Ecology of the diatom communities of the Upper Madison River System, Yellowstone National Park. Ph.D. Diss. Montana State Univ., Bozeman.

3E-42 Royse, C. F., Jr. 1970. A sedimentologic analysis of the Tongue River-Sentinel Butte interval (Paleocene) in the Williston Basin, western North Dakota. Science 183: 1077-1079.

3E-43* Schumm, S. A. 1961. Effect of sediment characteristics on erosion and deposition in ephemeral stream channels. (See 1B-21).

3E-44 Sheldon, A. L. 1968. Species diversity and longitudinal succession in stream fishes. Ecology 49(2):193-198.

3E-45 Stalnaker, C. B., J. C. Arnette, et al. 1975. Effects of reduced streams flow upon trout populations. Utah Coop. Fishery Unit. Utah State Univ., Logan.

3E-46 U.S. Geological Survey. 1975. Water resources investigations of the U.S. Geological Survey in the Northern Great Plains coal region of eastern Montana, 1974-1975. U.S. Geol. Surv. Open File Rep. Helena, Mont.

3E-47 Valentine, K. A. 1947. Effect of water retaining and water spreading structures in revegetating semi-desert rangeland. New Mexico Exp. Sta. Bull. 341. New Mexico State Univ., Las Cruces.

3E-48* Ward, J. V. 1974. A temperature stressed ecosystem below a hypolimnal release mountain reservoir.
(See 3C-81-A).

3E-49 Water Resources Division. 1975. Yellowstone River Basin. Water Resources Situation Rep. Dep. Natural Resources and Conservation, State of Montana, Helena.

3E-50 Wilhm, J. L. 1970. Some aspects of structure and function of benthic macroinvertebrates populations in a spring. Am. Midl. Nat. 84:20-33.

3E-51 Wilhm, J. L., and T. C. Dorris. 1968. Biological parameters for water quality criteria. BioScience 18:477-481.

3E-52 Williams, L. G. 1962. Plankton population dynamics. Public Health Service Pub. No. 663. HEW, Washington, D.C.

3E-53-A Wlosinski, J. H., and C. B. Stalnaker. 1975. Development and analysis of a general stream simulation technique, p. 167-178. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 2. Eastern Montana Coll., Billings.

A model is being developed to be used as a tool to study aquatic stream systems. It is a general, abstract, dynamic, non-linear computer simulation. The ecosystem is envisaged as a horizontally homogeneous stretch of water. Switches and parameters are set in a manner that allows only processes relevant to a particular state variable to occur. It describes the energy flow within a stream ecosystem. It contains abiotic, animal and decomposer section.

The model has theorectical and managerial uses, allowing prediction of the impact of various perturbations within the system.

(From author's abstract).

3E-54 Wright, J. C., and R. A. Soltero. 1973. Limnology of Yellowtail Reservoir and the Bighorn River. Ecological Ser. EPA-R3-73-002. Office of Research Monitoring, EPA, Washington, D.C.

3E-55-A Yamamoto, T. 1975. Trend surface analysis of Powder River Basin, Wyoming-Montana, p. 280-288. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 3. Eastern Montana Coll., Billings.

The use of trend surface analysis of maps to provide scientific rational for the restructuring of surface mined land topography is discussed.

The technique and analysis of trend surface mapping is described.

(Abstracted by Sally Ralston).

IV. PLANTS

A. Plant Growth on Spoil Materials: Survival and Succession of Native and Introduced Species

4A-1-A Adams, L. M., J. P. Capp, and E. Eisentrout. 1971. Reclamation of acidic coal mine spoil with fly ash. Rep. of investigations No. 7504. Bur. Mines, USDI, Washington, D.C. 30 p.

Experiments in reclaiming acidic surface mined land with raw fly ash from bituminous-coal-fired power plants were conducted by the Bureau of Mines at two sites in northern West Virginia. Plots at both sites were treated with varying tonnages from three area power plants and were planted with a variety of grasses, legumes, trees and shrubs. Eight grasses and seven legumes were investigated. Greatest promise for growth under harsh conditions were shown by Kentucky 31 fescue, rye, and red top grasses, and birdsfoot trefoil, a legume. Survival of trees and shrubs was negligible. Addition of fly ash to the spoil increased the pH to a range tolerable to some types of plant growth, improved texture of the soil and increased the available water of the resulting mixtures. (Abstracted by author).

4A-2-A Aharrah, E. C., and R. T. Hartman. 1973. Survival and growth of red pine on coal spoil and undisturbed soil in western Pennsylvania, p. 429-444. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 1. Gordon and Breach, New York, N.Y.

Comparisons were made of 20-year old red pine plantations growing on spoil of Kittanning coal and on an adjacent undisturbed field in Clarion County, Pa. The old-field plantation shows greater growth in five different parameters, but the red pine is shown to have grown very well on the spoils, and compares quite well in many parameters with those reported in the literature. Percentage survival is higher on the spoil than in the old-field situation. Some measurements of red pine growing on Clarion coal seam spoil are also reported. (From author's abstract).
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-2, p. 78).

4A-3-A Aldon, E. F. 1973. Revegetating disturbed areas in the semi-arid Southwest. J. Soil Water Conserv. 28(5):223-225.

Fourwing saltbush and alkali sacaton, plants native to the area, have been used in a 20 year watershed rehabilitation project. Methods of growing transplants and field planting are described. Since vegetation is naturally light, planting results of 25 percent ground cover of perennial vegetation is considered excellent.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-4, p. 78).

4A-4-A Aldon, E. F., and H. W. Springfield. 1975. Techniques for establishing native plants on coal mine spoils in New Mexico. Third Symposium on Surface Mining and Reclamation. Vol. 1. Natl. Coal Assoc./Bitum. Coal Res., Inc., Lousville, Ky.

This paper describes the techniques required for successful revegetation in the New Mexico area. Since much of this area receives less than 8 inches of rain a year, supplemental irrigation is needed for year-round reclamation. Sprinkler irrigation systems were installed at two demonstration sites. Direct seeding and transplanting were done with emphasis on native species. Survival and growth were measured at 13 and 22 months because at least two growing seasons are needed to evaluate planting success in the southwest.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. 75-1, p. 137).

4A-5 Arnot, D. J. 1950. Initial survival of planted hardwoods in strip mine spoil banks of Indiana. M.S. Thesis. Purdue Univ., Lafayette, Ind.

4A-6 Artz, J. L., et al. 1970. Planting for wildlands and erosion control. Coop. Ext. Serv. Pub. C108, Univ. Nevada, Reno. 24 p.

4A-7-A Ashby, W. C., and M. B. Baker. 1968. Soil nutrients and tree growth under black locust and shortleaf pine in strip-mining plantings. J. For. 66:67-70.

In a coal strip mined area tree growth and soil nutrients levels were studied 24 years after pine plantings and 16 years after underplanting with hardwoods. Heights of black locust, yellow poplar, silver maple and osage orange, underplanted in a black locust plantation were greater than on shortleaf pine plants. Plant bioassay showed the soil from locust plantation to be more productive than soil from shortleaf pine plots. P and N added to the soil together gave significant growth response on both plots, K did not produce a significant response.
(From Commonw. Bur. Soils Annot. Bibliogr. 1456. No. 22).

4A-8-A Augustine, J. T., J. H. Vaden, and C. D. Baker. 1964. Evaluation of plants used in vegetating strip-mine spoil in the lonesome pine soil conservation district of Virginia. USDA Soil Conserv. Serv. 18 p.

About 50 varieties or strains of grasses, legumes, ground covers, shrubs, and trees were evaluated in field trials. A number have made good to excellent growth without added fertilizer or mulch on seemingly barren waste lands. pH of spoils varied from 4.5 to 7.7.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R64-1, p. 24).

4A-9* Barnhisel, R. I., and H. F. Massey. 1969. Chemical, mineralogical and physical properties of eastern Kentucky acid-forming coal spoil materials.

(See 2A-3-A).

4A-10-A Bengston, G. W., D. A. Mays, and J. C. Allen. 1973. Revegetation of coal spoil in northeastern Alabama: Effects of timing of seeding and fertilization on establishment of pine-grass mixtures, p. 203-214. *In* First Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

The study plots, all seeded to loblolly pine at the start of the test, were set up to include controls and all combinations of the following variables: seeding with combinations of three grasses; fertilization at three rates and two different times; and seeding and grading at two different times. Results of the three-year study showed that objectives of revegetation should determine the reclamation plans. For example, where grasses and pines were seeded together, pine seedlings have difficulty surviving. Where pine was seeded alone, there seemed to be better germination and survival in the freshly graded block because better seed bed conditions existed. Also where pine was seeded alone, fertilizer treatment had no effect in seedling germination and survival through the first growing season. Fertilization enhanced the growth of grass and the later growth of trees.

(From "Reclamation of Coal-Mined Land. A Bibliography with Abstracts." 1975. No. R73-13, p. 80).

4A-11* Berg, W. A. 1965. Plant-toxic chemicals in acid spoils.

(See 2A-5).

4A-12-A Berg, W. A., and E. M. Barrau. 1973. Composition and production of seedings on strip-mine spoils in northwestern Colorado, p. 215-224. *In* First Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

Alfalfa dominated vegetation on strip mine spoils in northwestern Colorado (6600 to 7600 feet elevation, 16 to 18 inches average annual precipitation) seeded two to eight years previously with a mixture of grasses and legumes. Dry matter production on spoils and soil-covered spoils was comparable when alfalfa was the dominant species. Dry matter production was greater on spoils where alfalfa was the dominant species than on soil-covered spoils where smooth bromegrass and wheatgrasses were the dominant species. Total nitrogen in the soil size fraction of the spoils ranged from 545 to 1205 ppm N as compared to 2700 ppm for surface soils in the area. The spoils contained about 70 percent coarse fragments and possibly have a more favorable moisture regime for growth of deep-rooted plants than the moderately fine to fine-textured soils common to the area.
(Abstracted by author).
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-15, p. 81).

4A-13* Berg, W. A., and W. G. Vogel. 1973. Toxicity of acid coal-mine spoils to plants.
(See 2B-2-A).

4A-14* Berge, H. 1970. The suitability of clay-slate spoil mounds for afforestation.
(See 2A-7).

4A-15 Bleak, A. T., N. C. Frischknecht, A. P. Plummer, and R. E. Eckert. 1965. Problems in artificial and natural revegetation of the arid shadscale vegetational zone of Utah and Nevada. J. Range Manage. 18:59-65.

4A-16-A Bond, J. J., et al. 1971. Progress report of revegetation studies on coal mine spoils of North Dakota. USDA Agric. Res. Serv., SWC Res. Rep. No. 427. Northern Great Plains Res. Center, Mandan, N.D.

Research initiated in 1970 regarding the evaluation of lignite coal mine spoils as a medium for growing plants at Stanton, North Dakota. Most of the field activities were concentrated at the Consolidation Coal Company Mine (Glenharold Mine).
(From Dalsted and Leistritz. 1973 bibliography. No. E-3, p. 16).

4A-17 Boulton, R. V. 1971. Opencast coalmining and conservation. Agriculture (London) 78(3):132-133.

4A-18-A Bramble, W. C. 1952. Reforestation of strip-mined bituminous coal land in Pennsylvania. J. For. 50(4):308-314.

The history of strip mine coal land and its reclamation by afforestation are outlined. Those species which have colonized naturally or have been planted successfully on the spoils are listed.
(Abstracted by Sally Ralston).

4A-19* Bramble, W. C., et al. 1948. Research on reforestation of spoil banks in Pennsylvania.
(See 1A-3-A).

4A-20* Breeding, C. H. J. 1961. Crown vetch as an aid to strip mine reclamation.
(See 1C-4-A).

4A-21 Brewer, R., and E. D. Triner. 1956. Vegetation features of some strip mined land in Perry County, Illinois. Trans. Ill. State Acad. Sci. 48:73-84.

4A-22-A Brooks, D. S., and A. F. Bates. 1960. Grasslands in the restoration of opencast coal sites in Yorkshire. J. Br. Grassl. Soc. 15:116-123.

From results on many farms it is concluded that alternate husbandry, based on cereals and leys, is almost as conclusive as continual grass to gradual reconditioning of the land and that such a policy offers reasonable returns.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 53).

4A-23-A Brown, J. H. 1962. Success of tree planting on strip-mined areas in West Virginia. W. Va. Agric. Exp. Sta. Bull. 473. Morgantown, W. Va. 35 p.

Successful stands were established on nearly 75% of the spoil bank area of the state. Black locust made up over 40% of the total number of trees planted while red, white and Scots pines and Norway spruce contributed 11.5 to 16.3%.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 26).

4A-24-A Brown, J. H. 1971. Height-growth prediction for black locust on surface mined areas of West Virginia. W. Va. Agric. Exp. Sta. Bull. Morgantown, W. Va. (Available from J. H. Brown, Ohio Agriculture Research and Development Center, Wooster, Ohio).

Growth of black locust was studied in areas of surface mined land for coal in 26 countries in West Virginia. Heights and ages of trees were determined and site variables were measured, including slope percent, aspect slope position, position of plot on spoil surface, elevation and extent of regrading.

Multiple regression analysis showed that over 60% of the total variation in height-growth of black locust in the study areas was accounted for by four variables studied: Slope percent, aspect, elevation, and extent of regrading. Using the multiple regression equation developed in the study, a table was constructed which can be used to estimate the average annual height growth of black locust on unplanted surface mined sites.

(Abstracted by author).

4A-25* Brown, J. H., and E. H. Tyron. 1960. The establishment of seeded black locust on spoil banks.

(See 1B-2-A).

4A-26* Chapman, A. G. 1967. Effects of spoil grading on tree growth.

(See 2A-16-A).

4A-27-A Clark, F. B. 1954. Forest planting on strip-mined land in Kansas, Missouri and Oklahoma. Central States Forest Exp. Sta. Tech. Pap. No. 141. U.S. Forest Serv. (Columbus, Ohio). 33 p.

Survival and early growth rate of species of trees planted at various locations in the 3-state area have been obtained from two experiments. Data are tabulated in the appendix.

(From author's summary).

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R54-1, p. 6).

4A-28-A Coates, U. A. 1960. Experiment in grassland establishment on colliery shale, Brickershaw Reservoir site, Abram. 1954-1960. Lancashire County Council Planning Dep., Lancashire County, England. 21 p.

A full account of the trials carried out to find the best method of establishing grass on coal shales. The shale was treated with topsoil, sewage, sludge, gulley refuse, and inorganic fertilizer. Preparation for seeding, seeding mixtures used and further management are recorded.

(From British bibliography, unpubl., p. 20).

4A-29* Cornwell, S. M. 1966. Anthracite mining spoils as a media for plant growth.
(See 2A-20-A).

4A-30* Crampton, C. B. 1967. Soil development on tips in South Wales.
(See 2B-5-A).

4A-31* Croxton, W. C. 1928. Revegetation of Illinois coal stripped lands.
(See 2A-22-A).

4A-32 Culbertson, R. E., and R. M. May. 1942. Planting spoil banks and ditches. Soil Conserv. 7(10):260.

4A-33* Curtis, W. R. 1973. Moisture and density relations on graded strip-mine spoils.
(See 2A-25-A).

4A-34-A Czapowskyj, M. M. 1969. Performance of hybrid poplars planted on anthracite coalmine spoils. U.S. Forest Serv., Northeast. For. Exp. Sta., Kingston, Pa. Also in Agron. Abstr. 1970:158.

Dormant cuttings of 28 hybrid poplars (*Populus* spp.) clones were planted in 12 blocks on 3 graded anthracite strip mine spoils derived from either gray shale, sandstone, or glacial till. The spoils varied considerably in physical characteristics, natural nutrient supply and reaction. Five year results showed that, of the three strip mine spoils, those derived from sandstone were the best for growth. Height-growth here ranged from 1.7 to 4.7 m; overall survival was 84%. Poplars planted on spoils from glacial till survived very well--81%, but height-growth ranged from 0.3 to 2.5 m and was less impressive. Gray shale spoils were the poorest media. Overall survival here was only 21% and height-growth was only 0.3 to 3.5 m. Individual clones were evaluated and best performers were recommended for particular spoil types.
(Abstracted by Sally Ralston).

4A-35* Czapowskyj, M. M. 1970. Experimental planting of 14 tree species on Pennsylvania's anthracite strip-mine spoils.
(See 2A-26-A).

4A-36-A Czapowskyj, M. M., and W. E. McQuilkin. 1966. Survival and early growth of planted forest trees on strip-mine spoils in the anthracite region. U.S. Forest Serv. Res. Note NE-46. Northeast. For. Exp. Station, Upper Darby, Pa. 26 p.

A study of survival and growth in all 6-year and older forest trees plantings on strip mine spoils of the anthracite region of Pennsylvania was conducted in 1962-1963 showed: (1) that overall age survival of all species was adequate (40-60%) provided no disturbance had occurred after planting and (2) that height-growth was generally comparable to growth on natural soils of average productivity. A spoil classification based on parent material was developed and a preliminary guide for forest trees planting on anthracite strip mine spoils was prepared.

(From British Bibliography, unpubl., p. 33).

4A-37-A Czapowskyj, M. M., J. J. Mikuluckey, and E. A. Sowa. 1968. Response of crownvetch planted on anthracite breaker refuse. U.S. Forest Serv. Res. Note NE-78. Northeast. For. Exp. Sta., Berea, Ky. 7 p.

Lime applications were essential to the establishment of crownvetch (*Caonilla varia* L.) on local breaker refuse in the Pennsylvania anthracite region, and mulch treatments were highly beneficial. Fertilizer applications have only a slight affect on either establishment or growth.

(From British bibliography, unpubl., p. 33).

4A-38-A Davidson, W. H., and G. Davis. 1972. Sprouting of thinned hybrid poplars on bituminous strip-mine spoils in Pennsylvania. U.S. Forest Serv. Res. Note NE-147. Northeast. For. Exp. Sta. 6 p.

Various thinning techniques were applied to 5-year old hybrid poplar stands on bituminous strip-mine spoils. Basal and stump sprays of 2, 4, 5-T in diesel oil were effective for killing the trees. There was no evidence that chemical treatments affected adjacent trees. Where trees were cut and stumps were not chemically treated, all clones sprouted prolifically. Dominance in sprout clumps was asserted soon after thinning. Sprouting vigor was affected more by site quality than clonal parentage. Results indicate that hybrid poplar can be successfully regenerated under coppice management or can be easily removed for stand conversion.

(Abstracted by author).

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. 72-13, p. 66).

4A-39-A Davis, G. 1964. Second-year results of hybrid poplar test plantings on bituminous strip-mine spoils in Pennsylvania. U.S. Forest Serv. Res. Note No. NE-19. Northeast. For. Exp. Sta. 7 p.

This publication summarizes the survival and height growth of 60 clones after two growing seasons. The paper gives soil characteristics of the six plots that were used and the plantings in each. Planting methods and results are discussed and the results are tabulated. Acidity was found to be the most important single factor relating to survival and height growth, since "height growth and survival generally increased as pH increased.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R64-5, p. 24).

4A-40-A Davis, G., and R. E. Melton. 1963. Trees for graded strip-mine spoils--Performance ratings for 15 species commonly planted in the bituminous region of Pennsylvania. Pennsylvania State For. School Res. Pap. No. 32. Pennsylvania State Univ., University Park. 4 p.

This is a cooperative study of 6 different agencies to investigate all phases of the problem of revegetating strip-mine spoils in Pennsylvania. This survey concerned tree survival and growth of plantations on graded banks to supplement information already obtained from ungraded banks. A table is included showing spoil characteristics of the major coal seams stripped in Pennsylvania.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R63-3, p. 19).

4A-41* Davis, J. D. 1965. Moisture tension in soils and its effect on weed seed germination.
(See 2A-27).

4A-42* Davison, A., and B. J. Jeffries. 1966. Some experiments on the nutrition of plants growing on coal mine waste heaps.
(See 2B-6-A).

4A-43-A DenUyl, D. 1955. Hardwood tree planting experiments on strip coal mine spoil banks of Indiana. Purdue Univ. Agric. Exp. Sta. Bull. No. 619. Lafayette, Ind. 16 p.

This progress report discusses hardwoods planted in 1949 on Indiana spoil banks. Five growing seasons have elapsed since the planting of these trees which were 30 in number. Some 25 million trees have been planted since the passage of the reclamation law in 1941. Extensive information describes the many test plots and the characteristics of the spoil material. The species which are adapted for spoil bank planting are described individually and pictures show the progress of growth. The

summary lists eight types of trees and comments on their suitability for acid spoil planting.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R55-1, p. 7).

4A-44 DenUyl, D. 1956. Hardwood tree plantings on strip mine spoil banks. Proc. Ind. Acad. Sci. 65(1955):57-61.

4A-45-A DenUyl, D. 1962. Survival and growth of hardwood plantations on strip mine spoil banks of Indiana. J. For. 60:603-606.

A research project was set up in 1949 by Purdue University Agricultural Experiment Station and the Indiana Coal Association to determine the suitability of hardwood species for planting on spoil banks. It was considered that even after 11 growing seasons, the suitability of the 10 species for extensive use could not be determined. They were rated on percentage survival, height-growth and form of the tree. Only cottonwood reached crop tree size and it grew best in pure stands on non-toxic spoil.
(From British bibliography, unpubl., p. 36).

4A-46 Down, C. G. 1973. Life form succession in plant communities on colliery waste tips. Environ. Pollution 5(1):19-22.

4A-47 Dwyer, D. D. 1971. Preliminary findings on vegetation establishment on tailings material. Range Sci. Dep. Rep. 1 and 2. Utah State Univ., Logan. (Mimeo).

4A-48-A Ehrle, E. B. 1960. Pioneer shale bank communities. Castanea 25:80-83.

Comments on the colonization of shale banks at abandoned strip mines, with a list of herbaceous pioneer plants.
(Abstracted by Sally Ralston).

4A-49-A Einspahr, D. W. 1966. Coal spoil-bank materials as a medium for plant growth. Iowa State Coll. J. Sci. 30(3):352-353. (Abstr.)

Early spring seeding of legumes on newly stripped coal spoil bank areas was most successful. Light raking of the site after sowing more than doubled the stand densities. Grass establishment was best effected by seeding the grass with legumes or into established legume stands.
(From Herbage Abstr. 27).

4A-50* Einspahr, D. W., et al. 1955. Coal spoil-bank materials as a medium for plant growth.
(See 2B-13-A).

4A-51-A Funk, D. T. 1973. Growth and development of alder plantings on Ohio strip-mined banks, p. 483-491. *In* R. J. Hutnik and G. Davis (eds.). Ecology and reclamation of devastated land. Vol. 1. Gordon and Breach, New York, N.Y.

Alnus glutinosa plantations containing several European seed sources have survived and grown well on strip-mined areas in southeastern Ohio with pH ranging from 4 to 5. After seven years, trees from southern Germany were generally larger than those from northern Germany, Belgium, Denmark, or Sweden; the tallest 20 percent of the trees in the best seed source averaged 20.4 ft in height, and 2.7 inches in diameter at breast height (d.b.h.). Multiple stems were more common in trees from provenances showing slow height growth. Trees from all seed sources in the trial grew much better on lower slopes with adequate soil moisture than on well-drained upper slopes.

(From author's abstract).

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-59, p. 90).

4A-52-A Funk, D. T., and M. E. Dale. 1961. European alder: A promising tree for strip-mine planting. Central States Forest Exp. Sta. Note No. 151. U.S. Forest Serv. (Columbus, Ohio).

In spring, 1958, *Alnus glutinosa* seedlings were planted in seven plots on acid spoil on strip mined land in Ohio and Kentucky. After three growing seasons survival and growth were good on all but the most acid parts of the plots. The minimum pH at which good growth rate was attained was 3.5. When pH was greater than 3.5, growth and survival were even better, the best trees being more than 14 feet tall. *A. glutinosa* is expected to prove a valuable nurse species.

(From For. Abstr. 23(1962):3580).

4A-53-A Funk, D. T., and R. R. Krause. 1965. Fertilizering strip mine planting benefits some hardwoods. U.S. Forest Serv. Tree Planter's Notes 17:21-22. (Limited availability from D. T. Funk, Forestry Sciences Lab., Southern Illinois Univ., Carbondale, Ill.).

Eleven species of trees were planted on Ohio strip mine spoil with pH 5-7 and some were fertilized with pellets containing 28% N and 5% P_2O_5. After 2 years, American sycamore, European alder, and yellow poplar seedlings which had been fertilized were significantly taller than those which had not. However, fertilization significantly reduced yellow poplar survival. Seventy other species in the planting were affected less by fertilization.

(From British bibliography, unpubl., p. 38).

4A-54 Galbraith, J. H. 1971. A study of mine tailings and associated plants and groundwater in the Coeur D'Alene District, Idaho. M.S. Thesis. Univ. Idaho, Moscow.

4A-55-A Geyer, W. A. 1973. Tree species performance on Kansas coal spoils, p. 81-90. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 2. Gordon and Breach, New York, N.Y.

Preliminary analyses of 22 years of tree growth indicate several species are suitable for the reclamation of strip-mine spoils in the Kansas prairie-forest transition zone. For forest products, sycamore, eastern red cedar, bur oak, loblolly pine, and shortleaf pine were the best of the 13 species tested. Sycamore was by far the best performer. Many individuals over 50 ft tall and 6 inches in diameter could be found throughout the 1947 experimental planting areas. Black locust grows well, but it spread quickly and competes severely with other tree species.

(From author's abstract).

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-60, p. 91).

4A-56-A Geyer, W. A. 1971. Reforesting Kansas coal spoils. Agric. Exp. Sta. Circ. No. 399. Kansas State Univ., Manhattan.

In Kansas there are 45,000 acres of coal stripped land. A research program was set up in 1965 in order to: evaluate wood plant growth on mined lands; develop practical planting techniques; and determine the effects of mine spoil grading on plant growth. Programs, projects and results are discussed.

(From British bibliography, unpubl., p. 35).

4A-57-A Geyer, W. A. 1971. Survival and growth of trees on coal spoils in southeastern Kansas. Ph.D. Diss. Univ. Minnesota, Minneapolis. (Available from W. A. Geyer, Horticulture and Forestry Department, Kansas State Univ., Manhattan, Kans.)

Performance of 13 trees species planted in 1947 on coal spoils in Kansas were evaluated for survival for height, diameter, basal area and volume. Both graded and ungraded spoil banks with replicated 1/10 acre plots at 6 sites were used in the study. Conifers and hardwood performances were similar and most species had a site index rating of medium after 22 years growth. A woodlands reclamation guide for strip mine spoil is given.

Grading to a level topography was found to have an adverse effect on tree growth and is not advisable.

Recent plantings on three types of spoils in the same area studied the effect of "strike-off" grading on early survival and total height. Cottonwood, autumn olive and hedgeapple were not affected, but silver maple, bald cypress, sycamore and tulip poplar growth are suppressed on the first planes, especially on heavily textured spoils.

(From author's abstract).

4A-58-A Geyer, W. A. 1971. Timber growth on graded and ungraded strip-mine spoil banks in southeast Kansas. Trans. Kansas Acad. Sci. 74(3,4):318-324.

Compaction due to grading of silt loams and silty shales had an adverse effect on tree growth, probably due to moisture relations and spoil density.

(Abstracted by Sally Ralston).

4A-59-A Geyer, W. A., and G. G. Naughton. 1970. Growth and management of black walnut (*Juglans nigra* L.) on strip mine lands in southeastern Kansas. Trans. Kansas Acad. Sci. 73(4):491-501.

Black walnut plantations on partially leveled strip mined lands have been successfully established from seed. Dominant and co-dominant trees, after 32 years are 6.1 inches in diameter-breast height (DBH) and 33 feet; site index, 40-45 feet. After the 28th year, annual DBH growth had slowed to 1/10 inches. Low thinning and single tree release response was best at 0.18 inches. Management of poor site walnut should include early selection of individual high quality trees for release and pruning. Partial severing of thinned trees afforded live cover for small game.

(Abstracted by author).

4A-60* Geyer, W. A., and M. F. Rogers. 1972. Spoil change and tree growth on coal mined spoil in Kansas.

(See 2B-15)

4A-61* Gould, W. L., et al. 1972. Soil characteristics, biotic composition and vegetative production of areas leased by Western Coal Company for strip mining near Fruitland, New Mexico.

(See 2A-32-A).

4A-62* Graham, M. 1959. Erosion and the revegetation of spoil heaps: Some field trials.

(See 1B-11-A).

4A-63-A Grandt, A. F., and A. L. Lang. 1958. Reclaiming Illinois strip coal land with legumes and grasses. Agric. Exp. Sta. Bull. 628. Univ. Illinois, Urbana. 64 p.

In Illinois strip mining has produced an area of derelict land, comprised of a heterogenous mass of strata deposited in ridges with slopes ranging from 40 to 65% in conical piles or in sharply serrated ridges. The soils are relatively high in unweathered minerals containing P, K, Ca and Mg but lacking in organic matter and N. In the experiments described, over 70 species of grasses and legumes were sown in most cases directly on the spoil heaps and sometimes onto established vegetation such as *Melilotus* and weeds, or on relatively level areas. The most successful legume species were: Range and buffalo lucerne, birdsfoot trefoil, red clover, sweet clover, *Lespedeza*, and Kudzu. The grasses established themselves more slowly than the legumes. The most rapidly established were: Tall fescue, cocksfoot, and *Bromus inermis*. Early sowing, with a sowing rate of about 20% above the normal, was satisfactory. The grasses responded well to N but only to a small extent to other nutrients. The behavior of different plant species and various methods of sowing and preparing strip mined lands are described. (From Herbage Abstr. 30).

4A-64* Greenwood, E. F. 1963. Studies in the spread of plants onto pit heaps with special reference to the water relation of colonizing species.
(See 2B-16-A).

4A-65-A Grubb, H. F. 1965. The feasibility of vegetating mine tailings at Climax, Colorado. M.S. Thesis. Colorado State Univ., Fort Collins. 100 p.

This study was made to determine the feasibility of establishing vegetation on the mill tailings at Climax. The site is at an elevation of 11,000 feet in central Colorado. Mean annual precipitation is about 23 inches but the growing season is very short--the general environment is near alpine. The study included particle size distribution, cation exchange capacity, hydrogen ion activity, nutrients, and trace minerals. Various plant species were tested in the greenhouse and field. It was determined that nutrients must be added, the pH raised, and the surface stabilized for survival of vegetation. (From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

4A-66* Grube, W. E., Jr., et al. 1971. Spoil bank chemistry and its relation to plant growth.
(See 2A-33).

4A-67-A Günther, H. 1958. The use of poplar cuttings in spoil bank reclamation in lower Lusatia. Wiss. Abhandl., Deut. Akad. Landwirtz. - Chaftwiss, Berlin 16:57-70. (English Transl. by D. T. Funk)

Poplar cuttings have a higher survival rate on spoil banks than 2-year old seedlings. Application of lime is more beneficial than applying lime in holes. Planting of pioneer species may give protection to poplar cuttings and help their establishment.
(From British bibliography, unpubl., p. 40).

4A-68* Hall, I. G. 1956. The ecology of disused pit heaps in England. (See 2B-17-A).

4A-69* Harrington, T. A. 1960. Frost heaving ruins spoil bank seeding.
(See 1A-10-A).

4A-70-A Hart, G. E., and W. R. Byrnes. 1958. Performance of trees planted on coal stripped lands in the bituminous region of Pennsylvania. Pennsylvania State For. School Res. Pap. No. 28. Pennsylvania State Univ., University Park. Also in Wildl. Rev. 96:30. (Abstr.).

Data on height, survival and vigor after 10 years for 16 species on 22 sites are summarized. Best results were obtained with hybrid poplars, black locust, red oak, Japanese larch, jack pine and Scots pine.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 67).

4A-71 Heddleson, M. R., E. P. Farrand, and R. W. Ruble. 1962. Strip mine spoil reclamation. Coll. Agric. Ext. Serv., Pennsylvania State Univ., University Park. 14 p.

4A-72-A Hodder, R. L., and B. W. Sindelar. 1972. Coal mine land reclamation research located at Decker, Montana. Montana Agr. Exp. Sta. Res. Rep. No. 21. 26 p.

The research program at the Decker Coal Co. included overburden analysis; greenhouse testing for vegetation productivity potential; and field revegetation studies of over 40 individual seed mixtures containing over 70 plant species.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. 72-26, p. 69).

4A-73 Horn, L. M., and W. W. Ward. 1969. The revegetation of highly acid spoil banks in the bituminous coal region of Pennsylvania. Spec. Res. Rep. No. SR-71. Pennsylvania State Univ., University Park.

4A-74-A Jacoby, M. 1968. Growth, root growth and nutrition of beech plants on sites of different soil texture in the lignite area of the Rhineland. Diss. Zur Erlangung des Doktotgradesdes Forstlichen Faklitt at der Georg-August-Universitat Zu Göttingen In Hann, Minden. (Available from Jacoby, Tanneway 4, 5388 Hachenburg, West Germany).

Lands stripped for brown coal are being returned to agriculture of forestry. Six beech experimental plots were established on waste lands consisting of gravel, sand, loam, and loess (pH 5-8, sufficient phosphate, insufficient N). Their growth is compared with beech growing on a nearby grey forest soil. A plot without vegetation on toxic, tertiary sand is also discussed (pH 3, low phosphate, and insufficient N). Investigation of 8-year old beech showed the dependence of root development on soil texture.

Differences in length and weight of roots were more frequent and significant than in the shoots. Plant weights increase was directly proportional to the phosphate content of the soil.

(Abstracted by author).

4A-75-A Jacoby, P. W., Jr. 1968. Revegetation studies on coal spoil banks in southwestern Wyoming. M.S. Thesis. Univ. Wyoming, Laramie. 51 p.

This was a second phase of study at the Sorensen Coal Mine, following Lujan's work. Tests were made of crested and intermediate wheatgrasses, Russian wildrye, smooth bromegrass and alsike clover on various ages of spoils. Treatment included mulch, jute net, snowfence, irrigation and combinations of these. Succession of native, invading and introduced plants was noted. Economic evaluation of the treatments is given.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

4A-76-A Jacoby, P. W., Jr. 1969. Revegetation treatment for stand establishment on coal spoils banks. J. Range Manage. 22(2):94-97.

In field trials, opencast coal spoil banks 3, 9, and 15 years old were sown with mixtures of intermediate wheatgrass/crested wheatgrass (*Agropyron cristatum*)/ Russian wild rye/smooth brome at 12 lb./acre; and snow fencing, jute netting and straw mulch were used to facilitate establishment. Percentage seedling establishment increased with increase in age of the banks. All treatments gave seedling stands, but a combination of the jute netting and straw mulch gave the best results.

(From Herbage Abstr. 39).

4A-77-A Jones, R. G. 1966. Revegetation of mine spoil tips in South Wales coalfield. 6 p. Nat. Agric. Advisory Serv., Cardiff, South Wales, U.K. (Typescript, unpubl.).

A discussion of the physical conditions, natural colonization, seeding, planting, treatment and costs involved in the reclamation of strip mine pits in South Wales. Recommendations as to the nature of trials to find the best treatment before carrying out a reclamation project are made.

(From British bibliography, unpubl., p. 22).

4A-78-A Jones, W. G. (Year unknown). The new forest. Pa. Coal Mining Assoc., Phillipsburg, Pa.

Describes Rollingstone Tree Farms, an intensively managed forest on land once stripped for bituminous coal in central Pennsylvania. Gives detail of the 59 species planted. Profusely illustrated in color.

(From British bibliography, unpubl., p. 42).

4A-79-A Kendig, J. D. 1969. Hybrid poplar growth spurts. Coal Age 74(3):89.

A follow up visit to an anthracite spoil bank planting after 5 years showed that the trees grew slowly in drought years but grew exceptionally well when rainfall was normal. Rooted and unrooted hybrid poplar cuttings had the highest survival rate, especially on steep banks, where few unrooted cuttings survived.

The use of several different clones is recommended so that plants which will grow vigorously on spoil might be included, and the risk of insect damage and diseases is reduced.

(From British bibliography, unpubl., p. 42).

4A-80 Knudsen, L., and P. H. Struthers. 1952. Trees and pasture possible on land formerly used in strip mining. Ohio Farm Home Res. 37(278):72-73.

4A-81-A Land Agents' Society. 1951. Afforestation of colliery spoil heaps. Land Agents' Soc. J. 50:92,139,180,226,497.

Correspondence between readers giving information on species, methods of planting, etc.

(Abstracted by Sally Ralston).

4A-82 Limstrom, G. A. 1948. Extent, character and forestation possibilities of land stripped for coal in the central states. Central States Forest Exp. Sta. Tech. Pap. No. 109. Columbus, Ohio. 76 p.

4A-83* Limstrom, G. A. 1952. Effects of grading strip mined lands on the early survival and growth of planted trees.
(See 1B-14).

4A-84-A Limstrom, G. A. 1960. Forestation of strip-mined land in the central states. USDA Agric. Handbook No. 166. Washington, D.C. 74 p.

A summary of knowledge gained during the past two decades is presented as a guide to technicians engaged in the forestation of such land. There is a detailed discussion of the effects of site conditions, and the planting operations itself is fully described.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 11).

4A-85* Limstrom, G. A. 1967. How stripland grading affects survival and growth.
(See 1B-15).

4A-86* Lorio, P. L., Jr. 1963. Tree survival and growth in Iowa coal spoil material.
(See 1B-16-A).

4A-87-A Lorio, P. L., and G. E. Gatherum. 1965. Relationships of tree survival and yield to coal spoil characteristics. Iowa State Univ. Agric. and Home Econ. Exp. Sta. Res. Bull. 535. p. 394-403.

Survival and yield of two broadleaved and five coniferous species were related to selected chemical characteristics of coal spoil materials. Variables seemingly related to tree survival were pH, soluble salt concentration, exchangeable Al, cation exchange capacity and nitrification N. Correlation of variables with yield varied among species.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 1).

4A-88-A Lorio, P. L., and G. E. Gatherum. 1966. Growth of eastern cottonwood in relation to coal spoil characteristics. Iowa State J. Sci. 41:41-53.

Total height of *Populus deltoides* on coal spoil was related to the percentage of soil size material and to some nutrients in the spoils. Variation in the height was best accounted for by concentrations of soluble salts, exchangeable and soluble Ca, and percentage of soil size materials. Foliar N and initial tree height accounted for 42% of the variation in height increment, and the latter showed an inverse relationship to Mg. Tree growth is limited, at least on some coal spoil materials by P and N deficiencies.
(From Commonw. Bur. Soil Annot. Bibliogr. 1456. No. 47).

4A-89-A Lorio, P. L., G. E. Gatherum, and W. D. Schader. 1964. Tree survival and growth on Iowa coal spoil materials. Iowa State Univ. Agric. and Home Econ. Exp. Sta. Spec. Rep. No. 39. 11 p.

Green ash survived better than all other species on coal spoil materials and was best adapted to moist sites on moderately acid to calcareous spoils. Cottonwood grew much faster than other species and grew to more than double the height of green ash. Eastern red cedar showed best survival and growth on calcareous coal spoil materials but should not be planted on calcareous shales and glacial tills. Jack pines and Virginia pines were best adapted to dry sites on strongly and moderately acid materials. Pitch pines should be planted on more moist sites. Red and eastern white pine were best adapted to slightly acid, fertile moist, well-drained sites.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 11).

4A-90 Lowry, G. L. 1958. Conifer growth and survival varies on acid spoils. Ohio Farm Home Res. 43(311):20-21. Also in Wildl. Rev. 92:34. (Abstr.).

4A-91-A Lowry, G. L. 1960. Conifer growth is best on acid spoils. Ohio Farm Home Res. 45(3):44.

The establishment of conifers on strip mine spoil has been unsuccessful. The causes are soil acidity and lack aeration. In general, sandy or loose shaley spoils seem to allow satisfactory pine growth provided that soil acidity is between 3.5 and 5.8. Species which appear to do well on spoil/soil mixtures are pitch, ponderosa, Japanese red, Scotch and shortleaf pines. Growth of the pines may be improved by planting than with black locust which fixes N, but black locust tends to grow faster and eventually shades out the pines. Northern white cedar and eastern red cedar have shown satisfactory growth on spoils of pH range 5.5 to 7.0 and seem to tolerate more clay in the soil.
(From British bibliography, unpubl., p. 94).

4A-92* Lowry, G. L. 1961. Some physico-chemical characteristics of weathering coal spoils and their influence on the growth of pine seedlings.
(See 1A-15-A).

4A-93 Ludwig, W. D. 1923. Reforestation by coal companies in southwestern Pennsylvania. J. For. 21(5):492-496.

4A-94 Lwan, L. E. 1966. Revegetation of strip mined areas in southwestern Wyoming. M.A. Thesis. Univ. Wyoming, Laramie. 82 p.

4A-95 Magnuson, M. O., and R. L. Kimball. 1968. Revegetation studies at three strip-mine spoil sites in north-central Pennsylvania. Rep. of Investigations No. 7075. Bur. Mines, USDI, Washington, D.C. 12 p.

4A-96 Maloney, M. M. 1941. Revegetation on coal stripped land near Henryetta, Oklahoma. Proc. Okla. Acad. Sci. 22:123-129.

4A-97 May, M. 1975. Moisture relationships and treatments in revegetating strip mines in the arid West. J. Range Manage. 28:334-335.

4A-98* McClurkin, D. C. 1967. Effects of selected grasses and legumes on soil erosion and recovery rates. (See 1C-17).

4A-99 Medve, R. J. 1974. Volunteer woody plants on reclaimed bituminous strip-mine spoils. Proc. Pa. Acad. Sci. 48:93-94.

4A-100-A Mellinger, R. H., F. W. Glover, Jr., and J. G. Hall. 1966. Results of revegetation of strip mine spoils by soil conservation districts in West Virginia. W. Va. Agric. Exp. Sta. Bull. 540. Morgantown, W. Va. 18 p.

Both successful revegetation of strip mine spoil and some of the problems are illustrated in this brochure. (From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R66-11, p. 38).

4A-101 Merkel, D. L. 1974. Revegetation in the Southwest--its hazards and successes, p. 189-192. *In* Second Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Louisville, Ky.

4A-102* Oborn, E. T. 1961. Iron content of soils and trees, Beavercreek stripmining area, Kentucky. (See 2A-57-A).

4A-103 Pearson, G. A. 1960. Tolerance of crops to exchangeable sodium. USDA Pub. AIB216. Washington, D.C.

4A-104-A Peterson, H. B., and R. Monk. 1967. Vegetation and metal toxicity in relation to mine, mill and smelter wastes. Utah Agric. Exp. Sta. Circ. 148. Utah State Univ., Logan. 75 p.

This annotated bibliography of the literature relating to effects of metal toxicity on plants is indexed by specific elements found in mine, mill and smelter wastes.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

4A-105* Petersen, L., et al. 1967. Soil problems and tree growth after lignite strip mining.

(See 2A-59-A).

4A-106-A Plass, W. T. 1968. Tree survival and growth on fescue-covered spoil banks. U.S. Forest Serv. Res. Note NE-90. Northeast. For. Exp. Sta., Berea, Ky.

In spoil bank revegetation the emphasis today is on protection. Quick cover plants overplanted to trees or shrubs are recommended on many sites. In this study we tried to determine how an established fescue cover affects tree survival and growth. We found the ground cover did not affect survival but did reduce height growth of sycamore and sweet gum. It had little effect on growth of white pine and loblolly pine.

(Abstracted by author).

4A-107-A Plass, W. T. 1972. Fertilization treatments increase black locust growth on extremely acid surface-mine spoils. U.S. Forest Serv. Tree Planter's Notes 23(4):10-12.

Black locust seedlings planted on extremely acid surface mine spoils responded to phosphate and nitrogen fertilizers during the first three years after planting. The three sources of phosphate were equally effective and all sources were most effective in combination with ammonium nitrate. Incorporating the phosphate fertilizer with the spoil at the planting site and placing the nitrogen in slits 6 to 8 inches from the tree was effective in this study.

(From author's abstract).

4A-108-A Plass, W. T. 1973. Revegetating surface mined land. Green Lands 3(2):26-28.

Chemical and physical characteristics of the overburden affect successful reclamation. The author gives practical examples of plant germination and growth on different types of overburden, and on spoils with varying treatments. There is a continuing search for plant materials adapted to acid spoils.

(From "Reclamation of Coal Mined-Land: A Bibliography with Abstracts." 1975. No. R73-108, p. 100).

4A-109-A Ragg, J. M. 1967. Report on an inspection of two restored opencast coal sites in Midlothian. Dep. Soil Survey, Macauley Inst., Aberdeen, U.K. (Unpubl.).

Two restored opencast coal sites were examined to find the reason for heavy colonisation by soft rush *Juncus effusus*. Examination of the soil profiles showed that drainage was not impeded by panned layers. Soft rush occurred in the original vegetation and when the topsoil was returned and seeded with grass and clover, the rush seedlings grew. Application of lime and fertilizer helped the rush to flourish and spread. It is suggested that cutting (to prevent seeding) and spraying (to kill established rushes) at an early stage (2 to 3 years after re-seeding) could have eradicated the rush.

(Abstracted by author).

4A-110* Richardson, J. A. 1958. The effect of temperature on the growth of plants on pit heaps.
(See 1A-17-A).

4A-111* Richardson, J. A., and E. F. Greenwood. 1967. Soil moisture tension in relation to the colonization of pit heaps.
(See 3B-20-A).

4A-112 Rogers, N. F. 1949. The growth and development of black walnut (*Juglans nigra* L.) on coal stripmined land in southeastern Kansas. Trans. Kansas Acad. Sci. 52(1):99-104.

4A-113* Rogers, N. F. 1951. Strip-mined lands of the western interior coal province.
(See 2A-66-A).

4A-114 Ruffner, J. D. 1965. Adaptation and performance of shrubs in mine spoil reclamation, p. 117-123. *In* Proceedings of the Coal Mine Spoil Reclamation Symposium. School For., Coll. Agric., Pennsylvania State Univ., University Park.

4A-115 Ruffner, J. D., and J. G. Hall. 1963. Crown vetch in West Virginia. W. Va. Agric. Exp. Sta. Bull. No. 487. Morgantown, W. Va. 19 p.

Crown vetch produced a good cover on stripmine spoil banks and road banks and was better than other legumes on shallow shale soils.

(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 22).

4A-116-A Ruffner, J. D., and W. W. Steiner. 1973. Evaluation of plants for use on critical sites, p. 3-12. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 2. Gordon and Breach, New York, N.Y.

The Soil Conservation Service used a comparative method for evaluating plants and techniques for use in critical area stabilization. The procedure is described. Nine species have been evaluated as suitable for vegetating drastically disturbed areas. Six other promising species will probably be recommended upon completion of this evaluation.

(From British bibliography, unpubl., p. 101).

4A-117 Sawyer, L. E. 1946. Indiana stripmine plantings. J. For. 44:19-21.

4A-118* Schramm, J. R. 1966. Plant colonization studies on black wastes from anthracite mining in Pennsylvania.

(See 1A-18-A).

4A-119* Schulze, E., and M. Ruzanie. 1969. Fertility and productivity of reclaimed loess soils that underwent cultivation for different periods in the brown coal region of Rhineland.

(See 2A-68-A).

4A-120-A Sedgley, E. F. 1974. Revegetation potential of western rangelands in the oil shale region, p. 29-33. *In* Second Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Louisville, Ky.

The various types of vegetation in different parts of the area are described and are related to the elevation of the land. However, present vegetation may not represent the natural vegetative pattern since other factors such as grazing and man's protection from natural fires may have altered it. The research needs identified will take many years to complete but present knowledge can be put to immediate use. Also, demonstration plots indicate that spent shale will support a variety of plants with proper leaching, mulching, fertilizing and irrigation.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R74-87, p. 131).

4A-121 Seidel, K. W. 1969. Seeded black walnut taller than planted walnut on Kansas spoil banks. Central States For. Exp. Sta. Note No. 148. U.S. Forest Serv. (Columbus, Ohio).

4A-122* Smith, R. M., et al. 1972. Properties of coal overburden that influence plant growth on mine spoils.
(See 2A-71).

4A-123-A Stolk, A. C., H. C. Evans, and T. Nilson. 1969. *Penicillium argillaceum* sp. nov., a thermo tolerant *Penicillium*. Trans. Br. Mycol. Soc. 53:307-311.

P. argillaceum has its minimum temperature at 15 degrees, its optimum at 35 degrees, its maximum at 50 degrees, and occurs in mine tips.

(From Commonw. Bur. Soils Annot. Bibliogr. 1456. No. 20).

4A-124* Sutton, P. 1973. Establishment of vegetation on toxic coal mine spoils.
(See 2A-76-A).

4A-125 Tarbor, G. L. 1954. The survival and growth of young hardwood plantations on the strip mine spoil banks of Indiana. M.S. Thesis. Purdue Univ., Lafayette, Ind.

4A-126* Taylor, H. M., et al. 1966. Soil strength and seedling emergence relations.
(See 2A-78).

4A-127* Thompson, H. W. 1958. Restoration of agricultural and other soils.
(See 2B-28-A).

4A-128-A Thor, E., and J. S. Kring. 1964. Planting and seeding of loblolly pines on steep spoil banks. J. For. 62:575-576.

On 6-year old spoil banks on silty clay loam of pH 4.1 to 5.3, the percentage survival and percentage stocking after 3 years were better for planted trees than for directly seeded spots. Due to closer initial spacing of seeded spots there was no difference in the total numbers of surviving trees in the two treatments. The main advantage of planting was more uniform distribution. Exposure did not significantly affect survival, but planted and seeded trees grow much faster on spoil banks with a southern exposure.

(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 14).

4A-129* Valentine, K. A. 1947. Effect of water retaining and water spreading structures in revegetating semi-desert rangeland.
(See 3E-47).

4A-130* Van Lear, D. H. 1971. Effects of spoil texture on growth of K-31 tall fescue.
(See 2A-81-A).

4A-131-A Vogel, W. G. 1970. Weeping lovegrass for vegetating strip mine spoils in Appalachia, p. 152-162. *In* Proceedings of the First Weeping Lovegrass Symposium. Noble Foundation, Ardmore, Okla.

Weeping lovegrass is useful for vegetating stripmine spoils in Appalachia because it produces quick cover on a wide range of spoil conditions. It is more tolerant of extremely acid spoils (pH 4.0 to 4.5) and of dry sites and summer growing conditions than most of the commonly used cool season grasses and legumes. It provides the desired quick cover during the first growing season but does not crowd out the companion species, which usually obtain dominance by the third growing season. When sown with direct seeded black locust, lovegrass is less competitive with the locust seedlings than are the oft-used cool season grasses. Nitrogen and phosphorus fertilizers are needed for establishing quick cover of lovegrass on many Appalachian coal mine spoils.
(Abstracted by author).

4A-132-A Vogel, W. G. 1974. All season seeding of herbaceous vegetation for cover on Appalachian strip-mine spoils, p. 175-186. *In* Second Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Louisville, Ky.

Mixture of temporary (quick cover) and long-lived (permanent) herbaceous species were sown periodically throughout the year on stripmine spoils in eastern Kentucky. Fair to excellent vegetative cover was established.
(Abstracted by author).

4A-133-A Wilhelm, S., and E. Bruning. 1964. Possibilities for growing grasses and clovers as pioneer plants in revegetating tips in the region of the Linkenhoerd lignite region near Frankfort. Z. Landkult 5(2):133-150 (With German, English, and Russian summaries).

pK was applied to a young, leveled lignite tip with a relatively high soil pH (about 6) and various plants were tested to help soil formation, prevent wind erosion, and lower the soil's resistance to moisture penetration. Grasses such as cocksfoot, *Arrhenatherum elatius*, and ryegrasses developed well at first, but owing to the

looseness of the soil were susceptible to drought and frost and did not perinnate. Red fescue, sheep's fescue, and especially *Phalarus arundinacea* developed slowly, but produced good swards.
(From Herbage Abstr. 34).

4A-134-A Wilson, H. A. 1961. Rhizosphere bacteria of some stripmine vegetation. Proc. W. Va. Acad. Sci. 33:15-20.

Bacteria were isolated from the roots, root washings and rhizospheres of *Andropogon* spp., alsike clover, red clover and lucerne growing on spoil, and from spoil on which there had been no vegetative growth. Medium sized gram negative rods predominated and most of the isolates required unidentified components of yeast extract for maximum growth. Root isolates were more able to produce polysaccharides from glucose than were isolates from any other source. Isolates from the bare soil had the least polysaccharide-producing ability.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 52).

4A-135-A Zarger, T. G., J. A. Curry, and J. C. Allen. 1973. Seeding of pine on coal spoil banks in the Tennessee Valley, p. 227-236. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 1. Gordon and Breach, New York, N.Y.

Results of tests by the TVA to determine the feasibility of establishing pine tree on coal spoil banks by seeding instead of planted nursery grown seedlings.
(Abstracted by Sally Ralston).

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B. Plants Best Suited for Reclamation of Coal Spoils

4B-1 Aldon, E. F. 1970. Fourwing saltbush can be field planted successfully. U.S. Forest Serv. Res. Note RM-173. Rocky Mountain For. Range Exp. Sta., Fort Collins, Colo. 2 p.

4B-2-A Boyce, S. G., and D. J. Neebe. 1959. Tree species for planting on strip-mined land in Illinois. Central States For. Exp. Sta. Tech. Pap. 164. U.S. Forest Serv. (Columbus, Ohio). 33 p.

Seventeen species were suitable for planting, 10 of these in all parts of Illinois and 7 in the southern counties. White pine and pitch pine did poorly. The performance of each species is detailed.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 63).

4B-3 Brown, R. W., R. H. Ruf, and E. E. Farmer. 1971. Suitability of *Ceanothus prostratus benthos* for the revegetation of harsh sites. U.S. Forest Serv. Res. Note 144. Washington, D.C. 12 p.

4B-4 Dahl, O. 1967. Trees, shrubs, roses and vines for Wyoming high altitudes. Agric. Ext. Serv., Bull. 447. Univ. Wyoming, Laramie. 30 p.

4B-5-A Davis, G. 1970. Research on revegetation and hydrology of surface mined areas. Coal Age 75(4):112.

Plant breeders are striving to develop plants which are adapted to adverse sites. The alternative is modification of the sites and fly ash, composed wastes, processed sewage and bark are being used for this. Also terraces and furrows are created for arresting erosion until vegetation is established. However, the best solution is to bury toxic materials during the mining operations so that the revegetation problem does not arise.
(From British bibliography, unpubl., p. 35).

4B-6* Grandt, A. F., and A. L. Lang. 1958. Reclaiming Illinois strip coal land with legumes and grasses.
(See 4A-63-A).

4B-7-A Hafenrichter, A. L., et al. 1968. Grasses and legumes for soil conservation in the Pacific Northwest and Great Basin states. USDA Soil Conserv. Serv. Handbook 339. Washington, D.C.

Experimental work on grasses and legumes over the past 32 years at various Soil Conservation Service plant material centers in Washington, Oregon, California, Nevada and Utah is summarized. Plants are grouped by rapid-developing short-lived grasses, rapid-developing long-lived grasses, saline- and alkali-tolerant, drought-resistant long-lived bunch and sod grasses, bluegrasses, fine-leveled grasses and legumes. Characteristics, adaptability, uses and planting of each is discussed. Maps of the agricultural zones of each state are given.
(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

4B-8 Hart, G., and W. R. Byrnes. 1960. Trees for strip mined lands. Northeast. For. Exp. Sta. Pap. 136. U.S. Forest Serv. (Upper Darby, Pa.). 36 p.

4B-9-A Horton, J. S. 1949. Trees and shrubs for erosion control in southern California mountains. Dep. Nat. Res., California State Board For., Sacramento, Calif.

Discusses trees and shrubs that have proved adaptable to planting in eroding areas of the Southern California Mountains. It also briefly describes the different types of eroding areas, outlines conditions that restrict the choice of what and where to plant, and suggests special precautions that are necessary to establish the selected species successfully. (Source: A. Thompson, PSC).
(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

4B-10* Jacoby, P. W., Jr. 1968. Revegetation studies on coal spoil banks in southwestern Wyoming.
(See 4A-75-A).

4B-11* Jacoby, P. W., Jr. 1969. Revegetation treatments for stand establishment on coal spoil banks.
(See 4A-76-A).

4B-12 Johnson, W. M., and A. C. Hull. 1949. Range forest species for seeding in Ponderosa pine areas. Rocky Mountain For. Range Exp. Sta. Res. Note No. 5. U.S. Forest Serv. (Fort Collins, Colo.).

4B-13-A Larsen, S., and D. Gunary. 1961. Phosphate requirements of lupins grown as a pioneer crop on culm measure soil with impeded drainage. Nature 189(4765):691.

Experiments show that lupino are not capable of mobilizing insoluble phosphate as previously believed. Cabbage and barley gave similar results in tests, hence lupino has no exclusive propoerty. Deeper roots of the lupino may enable the uptake of phosphates which would be unavailable to shallow root plants.
(From British bibliography, unpubl., p. 98).

4B-14-A Los Lunas Plant Materials Center. 1968. 1968 fiscal year annual report, highway beautification. Los Lunas Plant Materials Center, New Mexico.

A total of 161 varieties or accessions of plants are being evaluated at the Los Lunas Plant Materials Center for use in roadside stabilization, beautification and conservation. Field evaluations will be made on many of these. Fertilizer tests have been made along Interstate 25. An excelsior soil retention blanket has proved successful in protecting ditch bottoms and berm areas from water erosion. Sites are listed, sample seeding instructions are given, and test results of various species are discussed.
(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

4B-15 Lowry, G. L. 1956. Five year study evaluates forest tree varieties for spoil banks. Ohio Farm Home Res. 41(302): 70. Also in Wildl. Rev. 88:25. (Abstr.).

4B-16-A Lowry, G. L. 1961. Alder appears promising as spoil banks tree planting. Ohio Farm Home Res. 46(4):51.

The survival and growth of alder was studied in 19 areas which exhibited soil textures ranging from sandy loam to clay and acidities from pH 3.1 to 7.7. In general only those plots where acidity was below 3.5 had poor survival and growth resulting from adverse conditions. Above pH 3.5 survival was 85% or higher. Mixed planting is recommended to restrict insect and disease occurrence.
(From British bibliography, unpubl., p. 99).

4B-17-A Lujan, L. E. 1966. Revegetation of strip-mined areas in southwestern Wyoming. M.S. Thesis. Univ. Wyoming, Laramie. 82 p.

This study was made at the Sorensen Coal Mine testing native and introduced grasses, shrubs and trees (emphasis on latter) for survival in strip-mine spoil piles. Various combinations of irrigation, fertilization and site orientation were tried. Soil analyses, moisture

content and some soil temperatures are given. The mean annual precipitation is about nine inches. Survival rates are given and evaluations made.
(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

4B-18 McAtee, W. C. 1936. Groups of plants valuable for wildlife utilization and erosion control. USDA Circ. No. 412. Washington, D.C. 12 p.

4B-19 McCreery, R. A. 1971. Grasses and legumes useful in reclamation, p. 87-88. *In* Symposium on rehabilitation of drastically disturbed surface mined lands. Georgia Surface Mined Land Use Board, Macon, Ga., 4-5 Nov.

4B-20* McWilliams, J. L. 1969. Arnot bristly locust.
(See 1C-18-A).

4B-21-A Ministry of Agriculture. 1969. Seed mixture for land reclamation. Ministry of Agriculture, Fisheries and Food, England.

Notes suggesting the principles for selection of seed mixtures, rather than listing the wide variety and number of possible mixtures. On species, seed rates, availability of seed and turf nursery.
(From British bibliography, unpubl., p. 99).

4B-22-A Orr, H. K. 1975. Mine spoil reclamation research at the Belle Ayr Mine, northeast Wyoming, p. 304-307. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 3. Eastern Montana Coll., Billings.

Revegetation research at a strip mining site is described. Moderate success has been enjoyed at the time of this paper, the most limiting factor to their efforts having been a lack of moisture. The focus of this study was on the establishment of tree stands. Green ash, Russian olive and Rocky Mountain juniper trees proved to be the most successful species in the experiments.

Further research now in progress include trickle irrigation techniques, containerized planting stock and measures to conserve soil moisture such as crosswind farrowing and mulching. All these measures can, in some degree, be expected to also control erosion and movement of sediment from mine spoil areas.
(Abstracted by Sally Ralston).

4B-23-A Plass, W. T. 1973. Genetic variability in survival and growth of Virginia pine planted on acid surface-mine spoil, p. 493-507. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 1. Gordon and Breach, New York, N.Y.

Fifty-seven open-pollinated Virginia pine progeny from 10 natural stands scattered through Tennessee and Kentucky were evaluated under field and greenhouse conditions to determine if genetic variability would influence survival and growth on extremely acid spoil. Significant differences between progeny indicate that, through selection and breeding programs, there may be a possibility of developing improved planting stock for strongly acid surface-mine spoil.

(From author's abstract and introduction).

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-107, p. 100).

4B-24-A Plass, W. T. 1975. An evaluation trees and shrubs for planting surface mined spoils. USDA Forest Serv. Res. Pap. NE-317. Northeast Forest Exp. Sta., Upper Darby, Pa.

55 tree and shrub species were evaluated on two surface mine sites in eastern Kentucky. After 4 years growth comparison of survival and growth was used to identify the promising species for planting on acid spoils. Three species of birch and three *Eleagnus* species survived and grew well on a range of sites. Non-commercial tree species and shrubs adapted to acid surface mine spoils included silk trees, tree of heaven, French tamarisk, Japanese fleeceflower, and amur privet.

(From author's abstract).

4B-25 Plummer, A. P. 1970. Plants for revegetation of roadcuts and other disturbed or eroded areas. Intermountain Region Range Improvement Notes 15. U.S. Forest Serv., Washington, D.C. p. 1-8.

4B-26-A Richardson, B. Z., E. E. Farmer, R. W. Brown, and P. E. Packer. 1975. Rehabilitation research and its application on a surface mined area of eastern Mohtana, p. 247-265. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 3. Eastern Montana Coll., Billings.

The research was conducted at the site of a new Great Plains surface mining site. Preliminary objectives were: (1) to determine the minimum combination of treatments necessary to acheive an acceptable stand of grasses, shrubs and trees and (2) to assess the short- and long-term merits of various grass mixtures.

The techniques used in selecting seeds, planting and analysis are described in detail. 1973 and 1974 results are tabulated and discussed.
(Abstracted by Sally Ralston).

4B-27-A Rothwell, F. M. 1973. Nodulation of various strains of *Rhizobium* with *Robinia pseudoacacia* seedlings planted in strip-mine spoil, p. 349-355. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 1. Gordon and Breach, New York, N.Y.

Sixteen strains of *Rhizobium* were investigated to determine their ability to nodulate with *Robina pseudoacacia* L. seedlings which were grown in four eastern Kentucky strip-mine spoils. Three of the bacterial strains were effective in all spoil types and two strains nodulated in three of the four spoil types when the seedlings were grown under controlled conditions.
(From author's abstract).
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-126, p. 104).

4B-28-A Ruffner, J. D. 1962. New plants for strip-mine soils and shale soils. Soil Conserv. 27:209-210.

Crown vetch showed outstanding growth especially on less acid spoil banks. Sweet clover, although less effective, has remarkable erosion controllability. Narrow leaf trefoil is the best legume for dry shallow shale spoils. Tall oat grass is particularly suitable for moderately acid spoils of low fertility. Certain exotic bluestems show good tolerance of midsummer drought. Switch grass is suitable for steep or stoney high limey spoils.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 32).

4B-29-A Seidel, K. W., and K. A. Brinkman. 1962. Mixed or pure walnut plantings on strip-mined land in Kansas. Central States For. Exp. Sta. Tech. Pap. No. 187. U.S. Forest Serv. (Columbus, Ohio). 10 p.

Ten years after planting pure stands of black walnut were found to have better survival, greater height, and better form than walnut grown in mixture with black locust. On the basis of this study, black walnut should be planted with bur oak, sycamore, red cedar or green ash on spoil banks in southeastern Kansas. A logical mixture might consist of equal amounts of selected species.
(From authors' summary).
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R62-11, p. 18).

4B-30 Struthers, P. H. 1958. Forage species recommended for revegetation of strip mine land. Ohio Agric. Exp. Sta. 5 p. (Mimeo).

4B-31-A Struthers, P. H. 1960. Forage seedings help reclaim acres of spoil banks. Ohio Farm Home Res. 45(1):12-13.

Field trials of grasses and legumes on strip mined land in Ohio since 1952 have shown that generally species that do best on farm land are also best for strip mine use.

(From author's abstract).

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R60-9, p. 14).

4B-32* Struthers, P. H., and J. P. Vimmerstedt. 1965. Advances in stripmine reclamation.
(See 1B-22-A).

4B-33 Tabor, P. 1962. Permanent cover for road cuts and similar conditions by secondary succession. Agric. J. 54:179.

4B-34-A Thompson, W. W. 1969. Cover establishment on strip-mined areas using two rhizomatous grass species. M.S. Thesis. Univ. Wyoming, Laramie. 65 p.

This study at the Sorensen Coal Mine tested sprigging and sodding of two species of grasses in spoil piles. Species tested were inland saltgrass (*Distichlis spricata* var. *stricta*) and western wheatgrass (*Agropyron smithii*). Comparisons were made of the grasses, the two planting methods, seasons of planting, influence of age of spoils, orientation of slope, and influence of protection (snow-fence). Soil analyses, moisture readings, and soil temperatures were compiled. Survival rates were given and evaluations made.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

4B-35-A Tyner, E. H., R. M. Smith, and S. L. Galpin. 1948. Reclamation of strip-mined areas in West Virginia. Am. Soc. Agron. J. 40:313-323.

This paper reports results of revegetation obtained by West Virginia Agricultural Experiment Station on the canyon plots in northern West Virginia. The spoil materials were classified as A, B and C. A separate section is devoted to each type of spoil and details of the procedure used in each case are outlined. Since these spoils are acid, lime was used in each case. Pictures are included of the canyon area. Delaying reclamation three years produced better ground cover than a delay of one year. Recommendations are made for each type of spoil material. Root activity has much to do with the survival of plants since some penetrate further in search of water.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R48-3, p. 3).

4B-36 Tyron, E. H. 1952. Forest cover for spoil banks. W. Va. Agric. Exp. Sta. Bull. 357(1). Morgantown, W. Va.

4B-37-A Vimmerstedt, J. P. 1970. Stripmine reclamation: 22 years of continuing research. Ohio Rep. Res. Development 55(4): 60-61.

A brief summary of the work of the Ohio Agricultural Research and Development Center from 1948-1970. Some important findings are: (1) European alder could replace black locust as a nitrogen fixing tree for spoil plantings; (2) Peach orchards could be established on neutral or slightly alkaline spoil material; (3) Soil formation on spoil banks was more rapid when both trees and low growing plants were established than when either group was used alone. Other factors studied besides species suitability are: weathering of spoil material, slope stability, rain infiltration, drainage water quality and effect of earthworms on soil formation.

(From British bibliography, unpubl., p. 57).

4B-38 Vogel, W. G., and W. A. Berg. 1966. Selecting grasses and legumes for cover on acid strip mine spoils. Am. Soc. Agron. Abstr. Annu. Meet. 52.

4B-39-A Vogel, W. G., and W. A. Berg. 1968. Grasses and legumes for cover on strip mine spoils. J. Soil Water Conserv. 23:89-91.

Seven perennial grasses and legumes were tested in field trials and weeping lovegrass (*Eragrostis curvula*) provided initial cover on extremely acid spoils faster than any of the other plants. The relative success of establishment of plants is determined by pH. The plant cover may not be permanent but can protect the spoil surface until the trees are established. The seven species were: *Eragrostis curvula Festuca arundinacea, Lespedeza cuneata, L. stipulacea, L. striata, Lotus corniculutus,* and *Panicum virgatum*.

(From British bibliography, unpubl., p. 56).

4B-40 Zybura, E. L., and E. C. Roberts. 1965. Comparison of foliar and root development of ten coarse grasses for roadside use. Agric. Abstr. 1965:49.

C. Impact of Grazing and Wildlife on Reclamation Efforts and Vegetation in General

4C-1 Black, H. L. 1968. Populations of small rodents in relation to grazing by cattle on foothil rangelands. M.S. Thesis. Univ. Utah, Salt Lake City. 56 p.

4C-2 Box, T. W. 1967. Influence of drought and grazing on mortality of five west Texas grasses. Ecology 48:654-656.

4C-3 Cooper, H. W. 1953. Amounts of big sagebrush in plant communities near Tensleep, Wyoming, as affected by grazing treatment. Ecology 34:186-189.

4C-4 Hanson, C. L., A. R. Kuhlman, C. J. Erickson, and J. K. Lewis. 1970. Grazing effects on runoff and vegetation on western South Dakota rangeland. J. Range Manage. 23(6):418-420.

4C-5 Lang, R. L., O. K. Barnes, and F. Rauzi. 1956. Shortgrass range-grazing effects on vegetation and on sheep gains. Wyoming Agric. Exp. Sta. Bull. 343. Laramie, Wyo. 32 p.

4C-6 Schwan, H. E., D. J. Hodges, and C. N. Weaver. 1949. Influences of grazing and mulch on forage growth. J. Range Manage. 2:142-148.

4C-7 Sims, P. L., and J. S. Singh. 1971. Herbage dynamics and net primary production in certain ungrazed and grazed grasslands in North America, p. 59-125. *In* N. R. French (ed.) Preliminary analysis of structure and function in grasslands. Range Sci. Dep. Sci. Ser. No. 10. Colorado State Univ., Fort Collins.

D. Revegetation for Wildlife and Agriculture

1. Wildlife

4D-1 Birkenholz, D. E. 1958. Reclamation of a spoil area for wildlife purposes. M.A. Thesis. Southern Illinois Univ., Carbondale. Also in Trans. Ill. State Acad. Sci. 52(1-2):83-86.

4D-2* Carlson, C. G., and W. M. Laird. 1964. Study of spoil banks associated with lignite strip mining in North Dakota: A report prepared for the Thirty-ninth Legislative Assembly. (See 2A-14-A).

4D-3-A Dusek, G. L. 1975. Vegetational responses by substrate, gradient, and aspect on a twelve acre test plot in the Bull Mountains, p. 233-246. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 3. Eastern Montana Coll., Billings.

This paper, resulting from a portion of a wildlife study in the Bull Mountains, pertains to the changes in floral composition and cover during the three growing seasons following mining, grading and seeding a test pit located approximately 4.5 miles southeast of Roundup, Montana. Climate was described as semi-arid with great temperature extremes.

After broadcast seeding with a basic mixture and chemical fertilization the floral composition and utilization by mule deer were monitored during early July.

Various soil types and species found to be the most successful were discussed.

(From author's abstract).

4D-4-A Fowler, D. K., and C. H. Perry III. 1973. Three years development of a public use wildlife area on a mountain coal surface mine in southwest Virginia, p. 319-333. *In* First Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

The 9,760 acre Hagy Wildlife Management Area--lying in Lee and Wise Counties, Virginia--was established in 1969, with the signing of a three year cooperative agreement between the landowner, Penn Virginia Corporation; the Virginia Division of Mined Land Reclamation; the Virginia Commission of Game and Inland Fishereies; and the Tennessee Valley Authority. The primary objective was to demonstrate that coal surface mined land lying within the 10,000 acre site could be developed as an integral productive portion of a public-use wildlife area. This paper describes the terms of the cooperative agreement, outlines the roles and responsibilities of the cooperators, and reports the results of the first three years of reclamation and the techniques used to achieve them.

(From author's text).

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. 73-58, p. 90).

4D-5-A Gwynn, T. 1966. Reclaiming strip-mined lands by establishing game management areas--A progress report. Knife River Coal Mining Co., Bismarck, N.D. 27 p.

This publication is a progress report on the reclamation program implemented by the Knife River Coal Mining Company. The report summarizes the work accomplished at the various mining sites.

(From Dalsted and Leistritz, 1973 bibliography. No. E-23, p. 18).

This is a follow-up report of work done by Knife River Coal Mining Company on properties in North Dakota and Montana. Over 156,000 seedlings were planted during 1965 at various sites. Preliminary observations were made on plant survival. Wildlife use is considerable. This program is compared with reclamation progress in other states.

(Abstracted by Sally Ralston).

4D-6-A Holland, F. R. 1973. Wildlife benefits from strip-mine reclamation, p. 377-388. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 1. Gordon and Breach, New York, N.Y.

In a study of four widely separated Appalachian coal strip-mined areas reclaimed with various trees, shrubs and grasses and compared with adjacent untreated spoils the third year after test plantings, it was found that reclamation gave significant and, most likely, long-lasting benefits.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. 73-67, p. 92).

4D-7* McAtee, W. C. 1936. Groups of plants valuable for wildlife utilization and erosion control.

(See 4B-19).

4D-8 Riley, C. V. 1952. An evaluation of reclaimed coal strip mined lands as wildlife habitats. Ph.D. Diss. Ohio State Univ., Columbus. Also in Diss. Abstr. 18(3):740-743.

4D-9 Riley, C. V. 1953. Striplands can produce wildlife. Ohio Conserv. Bull. 17(6):2-3,30-31.

4D-10-A Riley, C. V. 1954. The utilization of reclaimed coal strip-lands for the production of wildlife, p. 324-337. *In* Transactions of the 19th North American Wildlife and Natural Resources Conference. Wildl. Manage. Inst., Washington, D.C.

This paper includes data obtained in Ohio during the period 1946-1952 and in Indiana and Illinois during the summer of 1949, on a survey of wildlife population on strip mined reclaimed land compared to the population on adjacent cropland, abandoned farmland and forestland. A 1200 acre tract of land was studied to determine wildlife populations. Animal counts, types of forest trees and ground covers are reported. Many rabbits were trapped as well as raccoons and woodchucks. Fish species were also determined in the various lakes. It was decided that reclaimed coal strip mine land does compare favorably with other areas as producers of wildlife habitats.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R54-4, p. 7).

4D-11-A Riley, C. V. 1957. Reclamation of coal strip mined lands with reference to wildlife plantings. J. Wildl. Manage. 21:402-413.

The survival of 37 species which had been planted on coal strip mined lands in Ohio was evaluated in 72 study areas. The species had been planted for forestry and grazing and were potentially useful to wildlife. That included grasses, legumes, shrubs, conifers and hardwoods.

(From British bibliography, unpubl., p. 49).

4D-12-A Riley, C. V. 1963. Revegetation and management of critical sites for wildlife, p. 269-283. *In* J. B. Treethen (ed.) Transactions of the 28th North American Wildlife and Natural Resources Conference. Wildl. Manage. Inst., Washington, D.C. Also in Wildl. Rev. 112:17. (Abstr.).

The objectives of this study were to field test and evaluate the adaptability of various plant species having possible value to wildlife on sites varying in acidity and toxicity; to develop wildlife management techniques, and to apply these methods both during initial reclamation of strip lands and to older established plant communities. Characteristics of the strip mine sites are listed together with the analytical conditions of the soil on the stripped and undisturbed land. Tabulated evaluations are included for trees, grasses, and legumes, shrubs and vines. A total of 78 composite soil samples were tested, 85 plant species were field tested on 107 strip land plots and 57 species were rated as being successful.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R63-14, p. 21).

4D-13-A Ruffner, J. D. 1966. An evaluation of species planted on coal strip mine spoil in West Virginia for stabilization purposes. Soil Conserv. Serv., Morgantown, W. Va.

The paper discusses the relative success in establishment and value (for timber, winter food supply for animals and cover) of different species of trees, shrubs and herbs. Common, rather than botanical, names are used throughout, which could be a source of confusion. Plot experiments tested the effect on plant growth of fertilizer and lime. The growth of different species for each treatment is recorded.

(Abstracted by Sally Ralston).

4D-14 Smith, W. H. 1955. Strip mine to hunt uses. Southern Illinoisian 63:256.

2. Agriculture

4D-15 Allan, P. F., and W. W. Steven. 1959. Autumn olive for wildlife and other conservation uses. U.S. Dep. Agric. Leafl. 458. Washington, D.C.

4D-16-A Anonymous. 1963. New life for coal lands. Excavating Eng. 57(11):26-29.

The article describes how surface mined land can support farms, recreation, or homesites.
(Abstracted by Sally Ralston).

4D-17 Beattie, J. M. 1957. Fillar analysis shows value of spoil banks for fruit planting. Ohio Farm Home Res. 42(307): 65-67.

4D-18 Beattie, J. M. 1961. Recent findings in connection with peach production on strip mine spoil banks, p. 135-142. *In* Proceedings of the 114th Annual Meeting of the Ohio State Horticultural Society. Cleveland, Ohio.

4D-19 Blood, W. J., H. Jackson, and J. F. Ormrod. 1961. Restoration to agriculture of land worked for ironstone and levelled without the addition of topsoil. Exp. Husb. 6:90-99.

4D-20-A Davis, G., and D. H. Davidson. 1968. Coal-mine spoil banks offer good potential for timber and wildlife production. Pa. For. 58(1):2 p.

Editorial article explains the producing potential of strip-mined areas. Although most spoil sites will produce timber products, only about one quarter can be classed as good, and about one quarter are too poor to produce timber. Conifers do especially well on spoil banks. Valuable hardwoods such as cherry, walnut, yellow poplar, and sugar maple do not grow well on Pennsylvania spoil banks. Most promising hardwood is hybrid poplar. Reclamation can be designed specifically for wildlife production.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R68-5, p. 44)

4D-21-A Davis, G., and R. E. Melton. 1962. Plantations on strip-mine banks can yield timber products. Pennsylvania State For. School Res. Pap. No. 29. Pennsylvania State Univ., University Park. 2 p. Also in Wildl. Rev. 106:21. (Abstr.).

Ten of the oldest plantations on ungraded spoils were measured after 25 years or converted to a 25 year base to determine how well strip mine banks can produce timber products.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R62-6, p. 17)

4D-22* Dougall, B. M. 1950. The effects of opencast coal mining on agricultural land.
(See 2A-29-A).

4D-23-A Edmondson, P. A. 1961. Experiments on restored opencast coal sites: Winter wheat variety trials 1957-1959. Exp. Husb. 6:100-104.

Results of trials at different sites each year in the West Riding of Yorkshire indicated that, of six wheat varieties tested, Cappella gave slightly better yield than other varieties, particularly at high N levels, but that Welcome was to be preferred on account of its superior grain quality.
(From Field Crop Abstr. 14).

4D-24 Edwards, J. H. 1947. Unleveled spoil brings good return as farming project. Coal Age 1947 (February). 6 p.

4D-25-A Eshbaugh, F. P. 1949. The place of research in relation to certain phases of stripland reclamation in Kansas. Trans. Kansas Acad. Sci. 52:149-159.

The paper reviews the possibilities of establishing horticultural and fruit crops, bee-keeping and pastures on areas where opencast coal mining has taken place. A number of pasture developments are noted in which grass species have colonized such areas and have been grazed with fair success. Stands of *Melilotus alba* and *Lespedeza stipulaca* have been established, but have not so far proved a success.
(From Herbage Abstr. 20).

4D-26 Garcia, W. J., C. W. Blessin, G. E. Inglett, and R. O. Carlson. 1974. Physical-chemical characteristics and heavy metal content of corn grown on sludge-treated strip-mine soil. J. Agric. Food Chem. 22(5):810-815.

4D-27 Grandt, A. F. 1948. The potentialities of revegetating and utilizing agronomic species on strip mined areas in Illinois. Ill. Agric. Exp. Sta. and Illinois Coal Strippers Assoc. First Year Progr. Rep. 32 p.

4D-28 Grandt, A. F. 1950. The potentialities of revegetating and utilizing agronomic species on strip mined areas of Illinois. Illinois Agric. Exp. Sta. and Illinois Coal Strippers Assoc. Third Year Progr. Rep. 39 p.

4D-29 Grandt, A. F. 1952. The potentialities of revegetating and utilizing agronomic species on strip mined areas in Illinois. Illinois Agric. Exp. Sta. and Illinois Coal Strippers Assoc. Fifth Year Progr. Rep. 56 p.

4D-30* Heide, G. 1957. Fundamentals of agricultural reclamation in the Rhenish brown coal district.
(See 2A-38-A).

4D-31* Hodgson, D. R., et al. 1963. The reclamation of land covered with pulverized fuel ash: The influence of soil depth on crop performance.
(See 2A-39).

4D-32* Jones, W. G. (Year unknown). The new forest.
(See 4A-79-A).

4D-33-A Krause, R. R. 1964. Spoil bank goes from waste to fodder. Coal Mining Process 1964(May):4 p.

In the Ohio Power Co. project to develop pasture land from mined banks, research was carried out to determine species of grasses and legumes best adapted to the type of spoil, the best fertilization and seeding practices, and the optimum method of management for maximum meat production. Tabulated data gives soil constituents and certain fertilizer components. An original soil study was made in 1953 and samples have been analyzed at 2-year intervals since then.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R64-21, p. 27).

4D-34 Lang, R., and L. Landers. 1960. Beef production and grazing capacity from a combination of seeded pastures vs. native range. Wyoming Agric. Exp. Sta. Bull. 370. Laramie, Wyo.

4D-35* Omodt, H. W., et al. 1975. The properties of important agricultural soils as a criteria for mined land reclamation.
(See 2C-19).

4D-36 Sappenfield, V. 1956. Spoil-bank lands return farm profit in Indiana. Coal Age 61(5):82-84.

The Sherwood-Templeton Coal Co. of Indianapolis began to reclaim coal stripped land by planting corn, then expanded and developed farms. A full time farm manager was hired and a new division known as Maid Marian Farms was established. Spoil land area was then lime treated and used for pasture land. The company experimented with sub-soil fertilizing and several ground covers in an effort to learn which land should be used for farming and which should be planted in trees.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R56-4, p. 9).

4D-37 Seastrom, P. N. 1965. New land orchards. Proc. Coal Mine Spoil Reclamation Symp. (October 1965), School of Forest Resources, Coll. Agric., Pennsylvania State Univ., University Park.

4D-38* Tasker, J. 1957. Restoration of opencast coal land.
(See 2A-77-A).

E. General Plant Ecology

4E-1-A Albertson, F. W. 1937. Ecology of the mixed grass prairie in west-central Kansas. Ecol. Monogr. 74:481-547.

The structure and distribution of three types of mixed prairie in west-central Kansas have been determined and the factors controlling the distribution ascertained. (Abstracted by Sally Ralston).

4E-2 Albertson, F. W., D. A. Riegel, and G. W. Tomanek. 1966. Ecological studies of blue grama grass (*Bouteloua gracilis*). Fort Hays Stud. Sci. Ser. No. 5. Fort Hays Kansas State Coll., Hays, Kans. 37 p.

4E-3-A Anderson, N. L. 1964. Some relationships between grasshoppers and vegetation. Ann. Entomol. Soc. Am. 57:736-742.

Both the taxonomic composition and physical structure of the vegetation are found to play an important role in the selection of areas of occupancy by grasshoppers. There is evidence to suggest that changes in vegetation are directly responsible for initial fluctuations in population density.
(Abstracted by Sally Ralston).

4E-4-A Antonovics, J., A. Bradshaw, and R. G. Turner. 1971. Heavy metal tolerance in plants. Adv. Ecol. Res. 7:2-85.

This paper covers the genetics, evolution, ecology and mechanism of heavy metal tolerance in plants. Geographic and taxonomic investigations are described. Practical applications to the establishment of vegetation on toxic waste material are described.
(Abstracted by Sally Ralston).

4E-5 Arnon, D. I., and C. M. Johnson. 1942. Influence of hydrogen ion concentration on the growth of higher plants under controlled conditions. Plant Physiol. 17(4):525-539.

4E-6-A Ayers, A. D. 1952. Seed germination as affected by moisture and salinity. Agron. J. 44(2):82-84.

Soil salinity can slow seed germination by decreasing the absorption of water by seeds. Salts can become toxic to the seeds when they are directly absorbed.
(Abstracted by Sally Ralston).

4E-7 Barnes, O. K., R. L. Lang, and A. A. Beetle. 1952. Grass establishment on Wyoming dryland. Wyoming Agric. Exp. Sta. Bull. No. 314. Laramie, Wyo. 24 p.

4E-8 Bever, W. 1951. What about South Dakota's sage brush. South Dakota Conserv. Digest 18(1):12-13.

4E-9 Blakeley, H. I. 1947. The role of brush control on habitat improvement on the Arkansas wildlife refuge. North Am. Wildl. Conf., Trans. 12:179-184.

4E-10 Blazer, R. E., and C. Y. Ward. 1958. Seeding highway slopes as influenced by fertilizers, lime and adaptation of species. Roadcut Development, Highway Research Board, National Acad. Sci., NRC Pub. No. 613, p. 21-39.

4E-11-A Bradshaw, A. D., R. W. Lodge, P. Jowett, and M. J. Chadwick. 1958. Experimental investigations into the mineral nutrition of several grass species. 1. Calcium level. J. Ecol. 46:749-757.

Seven grass species were each grown in media with different levels of calcium. The species reacted differently. The growth of *Lolium parenne, Agrostis stolonifera*, and *Cynosurus cristalis* increased markedly with increase of calcium. The growth of *Agrostis enuis* and *A. canina* increased slightly and *Nardus stricta* showed an increase at low calcium levels but was depressed at higher levels. (From British bibliography, unpubl., p. 95).

4E-12* Branson, F. A., et al. 1962. Effects of contour farrowing, grazing intensities and soils on infiltration rates, soil moisture and vegetation near Fort Peck, Montana. (See 2C-6).

4E-13 Branson, F. A., R. F. Miller, and I. S. McQueen. 1964. Effects of two kinds of geologic materials on plant communities and soil moisture, p. 165-175. *In* Forage plant physiology and soil range relationships. Spec. Pub. No. 5, Am. Soc. Agron., Madison, Wisc.

4E-14 Branson, F. A., R. F. Miller, and I. S. McQueen. 1965. Plant communities and soil moisture relationships near Denver, Colorado. Ecology 46:311-318.

4E-15 Branson, F. A., R. F. Miller, and I. S. McQueen. 1970. Plant communities and associated soil and water factors on shale derived soils in northwestern Montana. Ecology 51:391-407.

4E-16 Brown, R. W. 1971. Distribution of plant communities in southeastern Montana badlands. Intermountain and Range Exp. Sta. U.S. Forest Serv. (Ogden, Utah).

4E-17-A Bryan, G. G., and W. E. McMurphy. 1968. Competition and fertilization as influences on grass seedlings. J. Range Manage. 21:98-101.

Nitrogen and phosphorus starter fertilizer with two levels of weed competition in seedlings of five grass species were evaluated by standcounts, total sod reserves, and subsequent forage yields.
(Abstracted by Sally Ralston).

4E-18 Buckman, H. O. 1910. Moisture and nitrogen relations in dryland agriculture. Proc. Am. Soc. Agron. 2:121-138.

4E-19-A Clark, F. E., and E. A. Paul. 1970. The microflora of grassland. Adv. Agron. 22:375-435.

A review of the literature concerning the microflora of the grasslands.
(Abstracted by Sally Ralston).

4E-20 Cook, C. W. 1961. Seeding response and soil characteristics on adjacent sagebrush and desert Molly soils. J. Range Manage. 14:134-138.

4E-21 Cook, C. W. 1965. Grass seeding response to halogeton competition. J. Range Manage. 18:317-321.

4E-22 Cooper, S. 1975. Influence of harvest management and midseason nitrogen fertilization on yield, botanical composition and crude protein content of grass-legume mixtures. Montana Agric. Exp. Sta. Bull. 676. 15 p.

4E-23-A Cosby, H. E. 1965. Fescue grassland in North Dakota. J. Range Manage. 18:284-285.

Local areas of North Dakota grassland are dominated by rough fescue. The composition of the vegetation on these areas is very similar to that of the fescue grassland described in Canada. Small amounts of the species are widely distributed across the northern portion of the state.
(Abstracted by Sally Ralston).

4E-24 Costello, D. F. 1949. Natural revegetation of abandoned plowed ground in mixed prairie association of northeastern Colorado. Ecology 35:312-320.

4E-25 Dahlman, J. L., and C. L. Kucera. 1965. Root productivity and turnover in native prairie. Ecology 46:84-89.

4E-26 Despain, D. G. 1973. Vegetation of the Big Horn Mountains, Wyoming, in relation to substrate and climate. Ecol. Monogr. 43:329-355.

4E-27* Dix, R. L. 1958. Some slope-plant relationships of the Little Missouri Badlands of North Dakota.
(See 1B-9).

4E-28 Ellison, L. 1949. Establishment of vegetation on depleted subalpine range as influenced by microenvironment. Ecol. Monogr. 19:95-121.

4E-29 Ellison, L., and E. J. Woolfolk. 1937. Effects of drought on vegetation near Miles City, Montana. Ecology 18:329-336.

4E-30 Evanko, A. B. 1953. Performance of several forage species on newly burned lodgepole pine sites. Northern Rocky Mountain For. Range Exp. Sta. Res. Note 133. U.S. Forest Serv., Washington, D.C.

4E-31 Everson, A. C. 1969. Replacement of native plant communities with introduced communities and its impact on ecosystem function, p. 261-267. *In* R. L. Dix and R. G. Beidleman (ed.) The grassland ecosystem: A preliminary synthesis. Range Sci. Dep. Sci. Ser. No. 2. Colorado State Univ., Fort Collins.

4E-32 French, N. R. (Ed.). 1971. Preliminary analysis of structure and function in grasslands. Range Sci. Dep. Sci. Ser. No. 10. Colorado State Univ., Fort Collins. 387 p.

4E-33 Gadgil, R. I. 1969. Tolerance of heavy metals and the reclamation of industrial wastes. J. Appl. Ecol. 6:247-259.

4E-34 Gibbons, R. P., and R. D. Pieper. 1962. The response of browse plants to fertilization. Calif. Fish and Game 48:268-281.

4E-35 Hayward, H. E., and C. H. Wadleigh. 1949. Plant growth in saline and alkali soils. Adv. Agron. 1:1038.

4E-36 Herbel, C. H. 1972. Environmental modification for seedling establishment, p. 101-114. *In* V. B. Youngner and C. M. McKell (eds.) The biology and utilization of grasses. Academic Press, New York.

4E-37 Hinds, W. T. 1970. Observations on the growth of cheat grass on a small earth mound. *In* Pacific Northwest Laboratory Annual Report for 1968. Vol. 2. Battelle Northwest Lab. Rep. No. BNWL-1051. Richland, Wash.

4E-38* Hinds, W. T. 1969. Elevational alteration of temperature/precipitation relations in a semi-arid shrub steppe: A preliminary survey.
(See 1A-12).

4E-39 Hinds, W. T., and J. M. Thorp. 1970. Foliar interceptions of precipitation in sagebrush communities, p. 134-135. *In* Pacific Northwest Laboratory Annual Report for 1969 to the USAEC Division of Biology and Medicine. Vol. 2, Physical Sciences. Part 1, Atmospheric Sciences. Battelle Northwest Lab. Rep. No. BNWL-1307 (part 1). Richland, Wash.

4E-40 Houlton, H. A. 1975. A six year study of vegetative response to nitrogen fertilization on range in North Central Montana. Montana Agric. Exp. Sta., Bozeman, Mont.

4E-41 Houston, W. R. 1963. Plains prickly pear, weather and grazing in the northern Great Plains. Ecology 44:569-574.

4E-42 Hubbard, W. A., and S. Smoliak. 1953. Effects of contour dykes and furrows on shortgrass prairie. J. Range Manage. 6:55-67.

4E-43 Hyder, D. N., A. C. Everson, and R. E. Bement. 1971. Seedling morphology and seeding failures with blue grama. J. Range Manage. 24:287-292.

4E-44 Jacoby, J. A., O. M. Anderson, Jr., C. L. Murdock, and L. E. Foote. 1967. Turf establishment on highway right of way slopes--a review. Highway Res. Record 161:1439.

4E-45 Judd, I. B. 1939. Plant succession on the Scoria Buttes of western North Dakota. Ecology 20:335-336.

4E-46* Kaul, R. N., et al. 1966. Micro-relief as a decisive factor in the development of vegetation in arid zones. (See 1B-13).

4E-47-A Koller, D., A. M. Mayer, A. Poliakoff-Mayber, and S. Klein. 1962. Seed germination. Annu. Rev. Plant Physiol. 13: 437-464.

A good review paper on seed germination. Temperature, light, water and other factors are discussed. (Abstracted by Sally Ralston).

4E-48 Kozlowski, T. T. 1972. Physiology of water stress. *In* C. M. McKell (ed.) Wildland shrubs--Their biology and utilization. U.S. Forest Serv. Gen. Tech. Pap. INT-1. Intermountain For. Range Exp. Sta., Ogden, Utah.

4E-49 Lauenroth, W. K., and W. C. Whitman. 1977. Dynamics of dry-matter production in a mixed grass prairie in western North Dakota. Oecologia. (in press).

4E-50 Levitt, J. 1972. Responses of plants to environmental stresses. Academic Press, New York. 697 p.

4E-51* McColley, P. D., and H. S. Hodgkinson. 1970. Effects of soil depth on plant production.
(See 2C-15).

4E-52 McGinnies, W. J. 1960. Effect of moisture stress and temperature on germination of six range grasses. Agron. J. 52:159-162.

4E-53 McGinnies, W. J., D. F. Hervey, J. A. Downs, and A. C. Everson. 1963. A summary of range grass seeding trials in Colorado. Agric. Exp. Sta. Tech. Bull. 73. Colorado State Univ., Fort Collins, Colo. 81 p.

4E-54 McKee, W. H., R. E. Blazer, C. K. Curry, and R. B. Cooper. 1964. Effects of microclimate on adaptation of species along Virginia highway banks. Agron. Abstr. 1964:102.

4E-55 McKell, C. M. (Ed.) 1972. Wildland shrubs--Their biology and utilization. U.S. Forest Serv. Gen. Tech. Pap. INT-1. Intermountain For. Range Exp. Sta., Ogden, Utah. 484 p.

4E-56-A McMillan, C. 1959. The role of ecotypic variation in the distribution of the central grassland of North America. Ecol. Monogr. 29:285-308.

Flowering time of several grasses was shown to be genetically determined and different for southern and northern ecotypes.
(Abstracted by Sally Ralston).

4E-57 Medin, D. E., and R. B. Ferguson. 1972. Shrubs establishment on game range in the northwestern U.S. *In* C. M. McKell (ed.) Wildland shrubs--Their biology and utilization. U.S. Forest Serv. Gen. Tech. Pap. INT-1. Intermountain For. Range Exp. Sta., Ogden, Utah.

4E-58* Meyer, L. D., et al. 1971. Run-off and revegetation of denuded construction sites.
(See 1C-20).

4E-59 Montana Agriculture Experiment Station. 1970. Forage crop varieties in Montana. Montana Agric. Exp. Sta., Montana State Univ., Bozeman, Mont.

4E-60-A Morris, M. S., and R. E. Lovegrove. 1975. The topographic and edaphic distribution of several plant communities of warm and cool season species in southeastern Montana, p. 684-702. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 5. Eastern Montana Coll., Billings.

The environmental factors controlling the distribution of a number of distinctive plant communities on the landscape within a limited area were studied. Six micro-communities were distinguishable: (1) *Calamovilfa longifolia-Andropogon scoparius* (2) *Andropogon scoparius-Carex filifolia* (3) *Festuca idahoensis-Stipa comata* (4) *Stipa comata*-prairie Junegrass (5) *Stipa viridula-Agropyron smithii* and (6) *Agropyron spicatum*-prairie Junegrass.

The distributions of the above micro-communities are described with respect to climate, topography, geology, soil type and moisture, grazing and fire history. (Abstracted by Sally Ralston).

4E-61* Negruckij, S. F. 1959. The danger of mine water to forest. (See 3B-18).

4E-62 Porter, L. K. 1969. Nitrogen in grassland ecosystems, p. 377-402. *In* R. L. Dix and R. G. Beidleman (eds.) The grassland ecosystem: A preliminary synthesis. Range Sci. Dep. Sci. Ser. No. 2. Colorado State Univ., Fort Collins.

4E-63 Rauzi, F., and A. R. Kuhlman. 1961. Water intake as affected by soil and vegetation on certain western South Dakota rangelands. J. Range Manage. 14:267-271.

4E-64 Richter, W. C. 1962. Shrub survival. Pa. Game News 33(3):62-64.

4E-65* Rickard, W. H. 1964. Demise of sagebrush through soil changes. (See 2C-23).

4E-66 Rickard, W. H. 1965. The influence of greasewood on soil moisture penetration and soil chemistry. Northw. Sci. 39:36-42.

4E-67 Rovira, A. D. 1965. Interactions between plant roots and soil microorganisms. Microbiology 19:241-266.

4E-68 Rumsey, W. B. 1971. Range seeding vs. climax vegetation on three sites in Idaho. J. Range Manage. 24:447-450.

4E-69 Sampson, A. W. 1914. Natural revegetation of range lands based upon growth requirements and life history of the vegetation. J. Agric. Res. 3:93-148.

4E-70 Schultz, A. M., J. L. Lauchbaugh, and H. H. Biswell. 1955. Relationship between grass density and brush seedling survival. Ecology 36(2):226-238.

4E-71 Schunetz, E. M., D. R. Cable, and J. T. Warwick. 1959. Effect of shrubs removal on the vegetation of a semi-desert grass-shrubs range. J. Range Manage. 12(1):34-37.

4E-72 Sorensen, T., and D. J. Holden. 1974. Germination of prairie forb seed. J. Range Manage. 27(2):123-126.

4E-73 Spedding, C. R. W. 1970. Grassland ecology. Clarendon Press, Oxford, England. 221 p.

4E-74 Stroh, J. R., and V. P. Sundberg. 1971. Emergence of grass seeding under crop residue. J. Range Manage. 24:226-230.

4E-75-A Terwilliger, C., C. W. Cook, and P. L. Sims. 1974. Natural and artificial rehabilitation of disturbed sites in an oilshale area, p. 17-25. *In* C. W. Cook (ed.) Surface rehabilitation of land disturbances resulting from oilshale development. Colorado State Univ. Infor. Ser. No. 11. Range Sci. Dep., Colorado State Univ., Fort Collins.

This paper deals mainly with various vegetation types and their natural rehabilitation, describing successional systems following complete disturbance, fire or chaining. Artificial rehabilitation is dealt with briefly.

A detailed description of the natural vegetation of the Piceance Basin is included.

(Abstracted by Sally Ralston).

4E-76-A Tolstead, W. L. 1941. Plant communities and secondary succession in south central South Dakota. Ecology 22(3): 322-328.

Studies of abandoned fields exhibited four stages of succession: (1) annual forb, (2) annual and perennial forb, (3) early perennial grass, and (4) climax bunch grass.

(Abstracted by Sally Ralston).

4E-77 Wali, M. K., and P. G. Freeman. 1974. Ecology of some mined areas in North Dakota. North Dakota Geol. Surv. Educ. Ser. No. 5. North Dakota Acad. Sci., Grand Forks. p. 25-47.

4E-78* White, E. M. 1971. Some soil age-range vegetation relationships.
(See 2C-28).

4E-79 Wilson, A. M., D. E. Wondercheck, and C. J. Goebel. 1974. Responses of range grass seeds to winter environments. J. Range Manage. 27(2):120-122.

4E-80* Wilson, H. A. 1957. Effect of vegetation on aggregation in strip mine spoil.
(See 2B-31-A).

4E-81* Wind, G. P. 1957. Root growth in acid soil.
(See 2B-34).

V. ANIMALS

A. Impact of Mining or Similar Disturbances on Local and Regional Species, Populations, and Communities

5A-1-A Arata, A. A. 1957. Trapping the striplands. Ill. Wildl. 12(4):5-6. (Coop. Wildlife Res. Lab., Southern Illinois Univ., Carbondale).

Muskrats, raccoons, opossums and a few mink were trapped on the banks of strip-mine ponds in Illinois in the mid 1950's.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R57-1, p. 9).

5A-2-A Arata, A. A. 1959. Ecology and management of muskrats in strip-mine ponds in southern Illinois. M.S. Thesis. Southern Illinois Univ., Carbondale. Also in 1959. The ecology of muskrats in strip-mine ponds in southern Illinois. J. Wildl. Manage. 23(3):177-186.

This study showed that while strip mine ponds did support muskrat, a number of adverse environmental factors probably contributed to low reproductive rates. Recommendations for improving strip mine ponds as muskrat habitat include leveling the banks, elimination of rock, use of economical water level control devices, and the development of greater areas of shallows to encourage growth of aquatic vegetation.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R59-1, p. 11).

5A-3-A Boccardy, J. A., and W. M. Spaulding, Jr. 1968. Effects of surface mining on fish and wildlife in Appalachia. U.S. Bur. Sport Fisheries Wildlife, Resource Publ. 65, Washington, D.C. 20 p.

This report on the effects of strip and surface mining on the fish and wildlife resources in eight Appalachian states is based in part on observations made during a tour of strip and surface mined areas by authors as members of a team of specialists from six federal agencies. Three of the eight states visited in 1965-66 had no laws requiring restoration of strip mined lands.

(From author's abstract).

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." No. R68-1, p. 44).

5A-4-A Brewer, R. 1958. Breeding-bird populations of strip-mined land in Perry County, Illinois." Ecology 39(3):543-545. Also in Wildl. Rev. 93:35. (Abstr.).

This paper is a study of bird populations on a tract of land strip mined between 1932 and 1950. Forty-four breeding species were counted and classified as forest edge birds. Most abundant of the species were the field sparrow, indigo bunting, mourning dove, and cardinal. A complete list of the bird species is tabulated.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R58-1, p. 10).

5A-5-A Bureau of Land Management. 1973. Powder River Basin resource briefing report. USDI, Bur. Land Manage., Casper District, Wyo.

This report details the many natural resources of the Powder Basin and describes the impact the development of the coal seams has and will have on the wildlife, agriculture and economics, and lifestyles of the area.

The expected magnitude of development will definitely cause some disturbances or destruction of other resources. The affected area may reach 1/2 million acres. The basic need is to adequately manage this development and mitigate or eliminate major environmental consequences and provide future rehabilitation and reconstruction of disturbed areas.

(From author's abstract).

5A-6-A Burner, C. C. 1973. Fishery management in strip mine lakes, p. 304-318. *In* First Research Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

A study of ten strip mine lakes in Kansas and six in Indiana has demonstrated that strip mine lakes can support good quality sport fishery. Fish populations can be established in lakes that have drainage from a fairly large watershed instead of only adjacent spoil banks; have an area greater than a half an acre; have a depth of over five feet; and a pH no less than 6. Fish stocking guidelines for these waters are given and suggestions are made of combinations of species and the conditions under which they should be used.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-20, p. 82).

5A-7 Burner, C., and R. Schoonover. 1958. Report on fisheries management projects in southeastern Kansas strip mine lakes. Kansas Forestry, State of Kansas, Fish and Game Comm., Topeka.

5A-8 Collins, F. W. 1957. Game management practices on strip mined lands, p. 213-221. *In* Proceedings of the 10th Annual Conference of the Southeastern Association of Game and Fish Commissioners. Columbia, S.C. Also in Wildl. Rev. 93:35. (Abstr.).

5-9* Cooper, E. C. 1966. Fish distribution in relation to acid mine drainage.
(See 3C-16).

5A-10* Cordone, A. J., and D. W. Kelley. 1961. The influence of inorganic sediment on the aquatic life of streams.
(See 3C-17-A).

5A-11* Dunger, W. 1967. The development of the macro and megafauna in reclaimed spoil heaps.
(See 2B-10-A).

5A-12* Dunger, W. 1969. Problems of the natural and experimental colonization with lumbricids, of soils unsuitable for cultivation.
(See 2B-11-A).

5A-13* Dunger, W. 1969. The role of arthropods in litter decomposition and the initial stages of soil formation.
(See 2B-12-A).

5A-14 Ecological Consulting Service. 1972. Preliminary wildlife and ecological report for Western Energy Company and Stearns-Roger Corp. of areas A, B, and certain spoils, Colstrip, Montana. Ecological Consulting Serv., Helena, Montana.

5A-15* Gash, S. L. 1968. Limnology and fisheries production of acid and alkaline strip mine lakes.
(See 3C-27).

5A-16* Gore, J. A. 1975. Fall-winter composition of the benthic macroinvertebrates of the Tongue River, Montana.
(See 3C-29-A).

5A-17-A Jewell, S. R., and R. J. Haynes. 1972. Research on strip-mining land by the Cooperative Wildlife Research Laboratory, S.I.U, p. 76-86. *In* Proceedings of the Annual Meeting of the Illinois Mining Institute. Ill. Mining Inst., Springfield, Ill.

The Cooperative Wildlife Research Laboratory has conducted surveys of wildlife, vegetation, effects of land management and habitat improvement, land suitable for acquisition for recreation, and land surface-mined prior to the first Illinois reclamation law. Results of various mining methods and soil chemistry of strip mine spoils have also been investigated.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R72-28, p. 69).

5A-18 Karr, J. R. 1968. Habitat and avian diversity on strip mined land in east central Illinois. Condor 70:348-357.

5A-19-A Kirkland, G. L., Jr. 1976. Small mammals in a mine waste situation in the central Adirondacks, New York: A case of opportunism by *Peromyscus maniculatus*. Am. Midl. Nat. 95(1):103.

A comparison of the small mammals found on mine wastes vs. natural areas. *P. maniculatus gracilis* comprised 83% of the mammals captured.
(Abstracted by Sally Ralston).

5A-20 Lokemoen, J. T. 1973. Waterfowl production on stock watering ponds in the Northern Plains. J. Range Manage. 26:179-184.

5A-21-A McCann, S. A. 1975. The movement and occurrence of small mammals on a reclamation plot, p. 318-324. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 3. Eastern Montana Coll., Billings.

Distribution and population levels of small mammals are related to floral composition and topography of strip mined lands in Musselshell County, Montana. Nine species of small mammals were found in the twelve acre experimental plot. Each species is described as to its apparent habitat preference and relative abundance. The species found were: *Peromyscus maniculatus osgoodii, Microtus pennsylvanicus insperatus, Sylvilagus floridanus, Eutamias minimus pallidus, Thomomys talpoides bullatus, Lepus townsendii campinius,* and *Marmota flavinentus nosophora*. The top soiled areas of the spoils received the heaviest use by the animals, the bare and/or rocky regions supporting the fewest species.
(Abstracted by Sally Ralston).

5A-22* Moffett, J. W. 1936. A quantitative study of the bottom fauna in some Utah streams variously affected by erosion.
(See 3C-46).

5A-23-A Morgan, R. L. 1973. Environmental impact of surface mining: The biologist's viewpoint, p. 61-71. *In* M. K. Wali (ed.) Some environmental aspects of strip mining in North Dakota. North Dakota Geol. Surv. Educational Ser. 5. Grand Forks, N.D.

Predicts severe future impact on North Dakota fish and wildlife due to strip mining coal.
(Abstracted by Sally Ralston).

5A-24 Myers, C. W., and W. D. Klimstra. 1963. Amphibians and reptiles of an ecologically disturbed (strip-mined) area in southern Illinois. Am. Midl. Nat. 70(1):126-132.

5A-25* Neumann, U. 1971. On succession of soil fauna in afforested spoil banks of the brown-coal mining district in Cologne.
(See 2B-22-A).

5A-26* Parsons, J. D. 1964. Comparative limnology of strip-mine lakes.
(See 3C-53-A).

5A-27-A Sly, G. R. 1976. Small mammal succession on strip-mined land in Vigo County, Indiana. Am. Midl. Nat. 95(2):257.

An analysis of small mammal succession on strip-mined lands of various ages in Indiana.
(Abstracted by Sally Ralston).

5A-28 Smith, H. G. 1964. Spoil banks and bird life. Soil Conserv. 30(4):77. Also in 1965, Wildl. Rev. 117:12. (Abstr.).

5A-29* Spaulding, W. M., and R. D. Ogden. 1968. Effects of surface mining on the fish and wildlife resources of the United States.
(See 3C-69-A).

5A-30 Verts, B. J. 1957. The population and distribution of *Peromyscus* on some Illinois strip mined land. J. Mammal. 38:53-59.

5A-31-A Verts, B. 1959. Notes on the ecology of mammals of a strip-mined area in southern Illinois. Trans. Ill. Acad. Sci. 52(3,4):134-139.

This article describes an ecological study of the wildlife potential of coal strip-mined lands in southern Illinois conducted August 4, 1954 to May 30, 1956. The area concerned had been strip mined from 1932 until 1950. A systematic count gave evidence of 26 species of mammals which were categorized into four ecological groups. It is suggested that changes in physical conditions due to increased height and canopy size of trees may be sufficient to initiate changes in mammal distribution.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R59-6, p. 12).

5A-32 Yahner, R. H., and J. C. Howell. 1975. Habitat use and species composition of breeding avifauna in a deciduous forest altered by strip mining. J. Tenn. Acad. Sci. 50(4):142-147.

5A-33 Yeager, L. E. 1942. Coal stripped land as a mammal habitat, with specific reference to fur animals. Am. Midl. Nat. 27:613-635.

B. Impact of Food Chain Disruption on Local and Regional Ecology

5B-1* Lind, O. T., and R. S. Campbell. 1970. Community metabolism in acid and alkaline strip mine lakes.
(See 3C-43).

C. The Importance of Invertebrates and the Impact of Coal Strip Mining on Them

5C-1 Bell, H. L., and A. V. Nebeker. 1968. Preliminary studies on the tolerance of insects to low pH. J. Kansas Entomol. Soc. 42(2):230-236.

5C-2-A Bromenshunk, J. J. 1975. Biological impact of air pollution on insects, p. 596-607. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 5. Eastern Montana Coll., Billings.

The primary objective of this paper is to describe some effects of air pollution on economically important insects. It does, however, stress the effect of the general disruption of insect life cycles on ecosystems. Economically important pollinators such as honeybees, butterflies, thrips, and beetles are the most susceptible to air pollution.
(From author's summary).

5C-3 Costley, R. J. 1936. An ecological survey of an artificially bared area and adjacent territory with special reference to the higher invertebrates. M.S. Thesis. Univ. Illinois, Urbana.

5C-4* Wilhm, J. L. 1970. Some aspects of structure and function of benthic macroinvertebrate populations in a spring.
(See 3E-52).

5C-5 Wilhm, J. L., and T. C. Davis. 1966. Species diversity of benthic macroinvertebrates in a stream receiving domestic and oil refinery effluents. Am. Midl. Nat. 76:427-449.

5C-6* Wilson, H. A., and G. Stewart. 1956. The number of bacteria, fungi, and actinomycetes in some strip mine spoil.
(See 2B-35).

D. Impact of Wildlife on Reclamation Efforts

5D-1* Blenkinsop, S. 1957. Some aspects of the problem of the restoration of opencast coal sites.
(See 2A-8-A).

5D-2 Bramble, W. C., and W. M. Sharp. 1949. Rodents as a factor in direct seeding on spoil banks in central Pennsylvania. J. For. 47:477-478.

5D-3-A Ferguson, R. B. 1968. Survival and growth of young bitterbrush browsed by deer. J. Wildl. Manage. 32(4):769-772.

Bitterbrush (*Purshia tridentata*), a preferred browse of deer on winter ranges in Idaho, has been frequently used in revegetation efforts. Recommendations on seeding procedures and management techniques are presented.
(Abstracted by Sally Ralston).

5D-4-A Hansen, R. M. 1970. Forage removal by jackrabbits on midgrass ranges. Annu. Meeting Colorado Sect. Am. Soc. Range Manage., 4-5 December, Denver, Colorado.

Jackrabbits appear to have removed about 180 lb./acre/year of forage at the Eastern Colorado Range Station during the time of this study.
(Abstracted by Sally Ralston).

5D-5 Julander, O., J. B. Low, and O. W. Morris. 1959. Influence of pocket gophers on seeded mountain range in Utah. J. Range Manage. 12(5):219-224.

5D-6 Rauzi, F., and C. L. Hanson. 1966. Water intake and run off as affected by intensity of grazing. J. Range Manage. 19:351-356.

5D-7* Sheldon, R. W., and P. J. Warren. 1966. Transport of sediment by crustaceans and fish.
(See 3C-67).

5D-8-A Vimmerstedt, J. P. 1969. Earthworms speed leaf decay on spoil banks. Ohio Rep. Res. Development 54(1):3-5.

Studies to find if earthworms could be established on spoil banks within a short time after revegetation and find their effect on the soil formation process. The earthworms, which were introduced to vegetated spoil, buried the litter and increased the mineral status of the soil. The decomposition process proceeded much more slowly in spoil without worms and was due to microbial activity.
(Abstracted by Sally Ralston).

E. General Animal Ecology Studies and Theory Pertinent to the Problem

5E-1 Allen, K. R. 1969. Distinctive aspects of the ecology of stream fishes: A review. Fish. Res. Board Can. J. 26: 1429-1435.

5E-2-A Anderson, A. E., D. E. Medin, and D. C. Bowden. 1972. Mule deer numbers and shrub yield-utilization on winter range. J. Wildl. Manage. 36(2):571-577.

Mule deer preferred true mountain mahogany (*Cercocarpus montanus*), antelope bitterbrush (*Purshia tridentata*), and big sagebrush (*Artemisia tridentata*).
(Abstracted by Sally Ralston).

5E-3 Anderson, W. 1956. A waterfowl nesting study on the grasslands, Merced County, California. Calif. Fish Game 42(2):117-130.

5E-4 Baker, T. 1953. Food habit study of game animals (antelope). Wyoming Wildl. 17(11):24-26.

5E-5-A Bayless, S. R. 1969. Winter food habits, range use, and home range of antelope in Montana. J. Wildl. Manage. 33(3): 538-551.

Sagebrush-grassland habitat type received the most use by antelope both in summer and winter. Forty-five percent of the winter diet of the antelope was provided by big sagebrush.
(Abstracted by Sally Ralston).

5E-6 Beale, D. M., and A. D. Smith. 1970. Forage use, water consumption and productivity of pronghorn antelope in western Utah. J. Wildl. Manage. 34(3):570-582.

5E-7 Bear, G. D. 1964. Food habits of the white tailed jackrabbits, Cochetopa Park, Colorado. M.S. Thesis. Colorado State Univ., Fort Collins. 135 p.

5E-8-A Boyd, R. J. 1970. Elk of the White River Plateau, Colorado. Colorado Div. Game, Fish, Parks Tech. Publ. No. 25. Denver, Colo. 126 p.

Sixty-six percent of the annual diet of these elk was grass. Forbs were important only during the summer months. Browse was used most extensively during the winter.
(Abstracted by Sally Ralston).

5E-9 Brown, R. L. 1966. Response of sharptail breeding populations to annual changes in residual grassland cover. Proc. Annu. Conf. Western Ass. State Game and Fish Comm. 46: 219-222.

5E-10 Cairns, J., Jr. 1969. Rate of species diversity restoration following stress in freshwater protozoan communities. Univ. Kansas Sci. Bull. 48:209-224.

5E-11 Campbell, R. N. 1961. The growth of brown trout in acid and alkaline water. Salmon Trout Magazine 161:47-52.

5E-12 Carpenter, L. H., and G. L. Williams. 1972. A literature review on the role of mineral fertilizers in big game range improvement. Colorado Div. Game, Fish and Parks Spec. Rep. No. 28. Denver, Colo.

5E-13 Cole, G. F., and B. Wilkins. 1958. The pronghorn antelope: its range and food habits in Central Montana with special reference to wheat. Tech. Bull. No. 2. Montana Fish and Game Dep., Helena, Montana.

5E-14 Compton, L. V., et al. 1974. Wildlife and game management on grasslands, p. 191-195. *In* H. B. Sprague (ed.) Grasslands of the United States. Iowa State Univ. Press, Ames.

5E-15 Coutant, C. C. 1963. Stream plankton above and below Green Lake Reservoir. Pa. Acad. Sci. Proc. 37:122-126.

5E-16 Coutant, C. C. 1966. Bacteria in an impounding reservoir. J. Am. Water Works Assoc. 58:1275-1277.

5E-17-A Davidson, W. H. 1970. Deer prefer pine seedling growing near black locust. U.S. Forest Serv. Res. Note NE-111. Northeast. For. Exp. Sta., Berea, Ky. 4 p.

The presence of volunteer black locust seems to make some pine species on a bituminous coal spoil more palatable to whitetail deer. Seedlings of jack pine, pitch pine and Austrian pine were browsed more heavily when within 10 ft of a black locust than when farther away. The nitrogen produced by the black locust may have caused more succulent tissues in the pines. Proximity of black locust did not seem to strongly influence browsing of other pine species in the study area.

(Abstracted by author).

5E-18 Diem, K. L. 1973. Wildlife--known environmental study. Romcoe Spec. Rep. 85 p.

5E-19-A Dietz, D. R., and L. R. Yeager. 1959. The apparent role of sagebrush in the management of mule deer winter range. Proc. Annu. Conf. Western Assoc. State Game Fish Comm. 39:151-158.

The mule deer populations of the western states depend heavily on sagebrush.
(Abstracted by Sally Ralston).

5E-20 Evans, K. 1963. Grouse of the grasslands. Colorado Outdoors 12(6):15-18.

5E-21-A Evans, K. E., and D. L. Gilbert. 1969. A method for evaluating greater prairie chickens habitat in Colorado. J. Wildl. Manage. 33(3):643-649.

Greater prairie chickens of northeast Colorado required grainfields for winter food and an abundance of tall-grass species for suitable nesting cover.
(Abstracted by Sally Ralston).

5E-22-A Fautin, R. W. 1975. The terrestrial vertebrate fauna of the Atlantic Richfield Company's Black Thunder coal lease property in Campbell County, Wyoming, p. 635-650. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 5. Eastern Montana Coll., Billings.

The paper presents qualitative and quantitative data on the terrestrial vertebrates of the Campbell Co., Wyo.-Federal coal lease block.

Twenty-one species of mammals representing eight families were found. Eleven species of rodents representing four families were captured. Other mammals included three species of rabbits, three species of mustelids, two species of deer, and the pronghorn antelope. The population size estimates and habitats of the above mammals are described.
(Abstracted by Sally Ralston).

5E-23 Feist, F. G. 1968. Breeding bird populations in relation to proposed sagebruch control in central Montana. M.S. Thesis. Montana State Univ., Bozeman.

5E-24-A Flake, L. D. 1969. A study of rodents in northeastern Colorado. US/IBP Grassland Biome Tech. Rep. No. 15. Colorado State Univ., Fort Collins. 29 p.

Relates small mammal populations to several biotic and abiotic factors in the environment. (Abstracted by Sally Ralston).

5E-25 Fleharty, E. D., and L. E. Olson. 1969. Summer food habits of *Microtus ochrogaster* and *Sigmondon hispidus*. J. Mammal. 50:475-486.

5E-26 Flinders, J. T. 1971. Diets and feeding habitats of jackrabbits within a shortgrass ecosystem. Ph.D. Diss. Colorado State Univ., Fort Collins. 75 p.

5E-27-A Hansen, L. E., and D. R. Progulske. 1973. Movements and cover preference of pheasants in South Dakota. J. Wildl. Manage. 37(4):454-461.

Alfalfa was the cover type most extensively utilized by pheasants during both day and night. (Abstracted by Sally Ralston).

5E-28-A Hansen, R. M., and B. L. Dearden. 1975. Winter foods of mule deer in Piceance Basin, Colorado. J. Range Manage. 28(4):298-300.

Examination of fecal samples showed that pinyon pine and Utah junipers comprised 83% of the winter diet. Contributing another 13% were big sagebrush, Utah serviceberry, and bitterbrush. (Abstracted by Sally Ralston).

5E-29 Hanson, C. L., A. R. Kuhlman, C. J. Erickson, and J. K. Lewis. 1970. Grazing effects on runnoff and vegetation in western South Dakota rangeland. J. Range Manage. 23:418-420.

5E-30 Hoffman, D. M. 1965. The scaled quail in Colorado. Range, population status, harvest. Colorado Game, Fish and Parks Dep. Tech. Pub. 18. 47 p.

5E-31 Jameson, E. W. 1955. Some factors affecting fluctuations of *Microtus* and *Peromyscus*. J. Mammal. 36(2):206-209.

5E-32 Jewell, M. E. 1922. The fauna of an acid stream. Ecology 3(1):22-28.

5E-33-A Jones, R. E. 1963. Identification and analysis of lesser and greater prairie chicken habitat. J. Wildl. Manage. 27(4):757-778.

Insects are the primary food source of the lesser prairie chicken, while the greater prairie chicken got most of its food from plants, mainly in the form of seeds.
(Abstracted by Sally Ralston).

5E-34 Kirsch, L. M. 1974. Habitat management considerations for prairie chickens. Wildl. Soc. Bull. 2(3):124-129.

5E-35 Klauber, L. M. 1956. Rattlesnakes: Their habits, life histories, and influence on mankind. Vol. 1 & 2. Univ. California Press, Berkeley. 1533 p.

5E-36 Kundaeli, J. N. 1969. Cottontail rabbit (*Sylvilagus audubonii cedrophilus*) response to pinyon-juniper removal. M.S. Thesis. Colorado State Univ., Fort Collins. 57 p.

5E-37 LoBue, J., and R. M. Darnell. 1959. The effects of habitat disturbance on a small mammal population. J. Mammal. 40(3):425-437.

5E-38 Mackie, R. J. 1968. Range ecology and relations of mule deer, elk, and cattle in the Missouri River Breaks. J. Wildl. Monogr. 32(3):597-614.

5E-39 Margalef, R. 1963. On certain unifying principles in ecology. Am. Nat. 97:357-374.

5E-40 Mason, E. 1952. Food habits and measurements of Hart Mountain antelope. J. Wildl. Manage. 16(3):387-389.

5E-41 Maxwell, M. H., and L. N. Brown. 1968. Ecological distribution of rodents on the high plains of eastern Wyoming. Southw. Nat. 13:143-158.

5E-42* McAtee, W. C. 1936. Groups of plants valuable for wildlife utilization and erosion control.
(See 4B-19).

5E-43 McCann, S. 1974. A four year study of *Peromyscus maniculatus* in Musselshell County, Montana. Proc. Montana Acad. Sci. 34:37-42.

5E-44 Mitchell, G. J., and S. Smoliak. 1971. Pronghorn antelope range characteristics and food habit in Alberta. J. Wildl. Manage. 35(2):238-250.

5E-45 Morris, M. S. 1957. Mule deer and elk food habits on the National Bison Range. J. Wildl. Manage. 21(2):189-193.

5E-46 Mussehl, T. W., and F. W. Howell. 1971. Game management in Montana. Montana Fish and Game Dep., Helena, Montana.

5E-47 Myton, B. 1974. Utilization of space by *Peromyscus leucopus* and other small mammals. Ecology 55:277-290.

5E-48 Nagy, J. G., and J. P. Hoover. 1971. Pronghorn antelope field food consumption studies. US/IBP Grassland Biome Tech. Rep. No. 87. Colorado State Univ., Fort Collins. 63 p.

5E-49-A Newell, R. L. 1975. Longitudinal changes in the macroinvertebrate fauna of the Yellowstone River, p. 199-211. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 2. Eastern Montana Coll., Billings.

Results of an inventory of the macroinvertebrates present in the Yellowstone River are reported. Species diversity indices were used to gain insight into the dominant species, longitudinal succession and quality of the fauna. The study was preliminary to an on-going effort to determine the stream flow requirements of the dominant macroinvertebrates.

Definite patterns were discerned in the longitudinal distribution of the macroinvertebrates, the most dramatic changes occurring in the Plecoptera and Trichoptera.

(Abstracted by Sally Ralston).

5E-50 Passey, H. B., and V. M. Hicks. 1970. Grasslands restoration and its effect on wildlife. U.S. Dep. Agric., Soil Conserv. Serv., Washington, D.C.

5E-51 Pearson, W. D., R. H. Kramer, and D. R. Franklin. 1968. Macroinvertebrates in the Green River below Flaming Gorge Dam, 1964-1965 and 1967. Proc. Utah Acad. Sci. 28:148-167.

5E-52-A Peterman, L. G., and M. H. Haddix. 1975. Preliminary fishery investigations on the lower Yellowstone River, p. 97-111. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 2. Eastern Montana Coll., Billings.

A progress report is given on the investigation of the life histories and distributions of important game, non-game and forage fish conducted since April 1974 on the lower Yellowstone River.

Three distinct habitat types are described with their characteristic gradients and flow. These systems are: (1) alpine, salmonid, (2) transition, and (3) warm water. Species diversity increased dramatically in zone 3. Lists of the species found in each zone are given.

A study designed and implemented to determine the importance of backwater areas to river fish populations is described. It focused on the utilization by species, reproduction and rearing, and forage fish production.

Preliminary results on the life histories of the following species were described: (1) shovelnose sturgeon, (2) sauger and (3) walleye.

(Abstracted by Sally Ralston).

5E-53-A Peterson, J. G. 1970. The food habits and summer distribution of juvenile sage grouse in central Montana. J. Wildl. Manage. 34(1):147-154.

Forbs comprised 75% of the diet of 127 juvenile sage grouse up to 12 weeks of age. The leaves and flower buds of common dandelion (*Taraxacum officinale*) and common salsify (*Tragopogon dubious*) were the most utilized forbs. Big sagebrush was used very little until the birds reached 11 weeks old. Good juvenile sage grouse habitat had an abundance of forbs and sagebrush densities of from 1-20%.

(Abstracted by Sally Ralston).

5E-54* Powers, E. B. 1930. The relationship between pH and aquatic animals.
(See 3E-40).

5E-55 Rickard, W. H. 1960. The distribution of small mammals in relation to climax vegetation mosaic in eastern Washington and northern Idaho. Ecology 41:99-106.

5E-56* Roeder, T. S. 1966. Ecology of the diatom communities of the Upper Madison River System, Yellowstone National Park.
(See 3E-41).

5E-57 Sagar, R. G. 1962. Soil and vegetation as limiting factors in cottontail rabbit abundance. Game Res. Ohio 1:129-131.

5E-58 Schneider, B. 1973. Be glad you're not an antelope. Montana Outdoors 4(2):16-21.

5E-59* Sheldon, A. L. 1968. Species diversity and longitudinal succession in stream fishes.
(See 3E-44).

5E-60 Soper, J. D. 1946. Mammals of the northern Great Plains along the international boundary in Canada. J. Mammal. 27(2):127-153.

5E-61 Spence, J. A., and H. B. N. Hynes. 1971. Differences in benthos upstream and downstream of an impoundment. Fish. Res. Board Can. J. 28:35-43.

5E-62 Stadnyk, L. 1971. Factors affecting the distribution of stoneflies in the Yellowstone River, Montana. Ph.D. Diss. Montana State Univ., Bozeman.

5E-63 Todd, J. W. 1972. A literature review of bighorn sheep food habits. Colorado Div. Game, Fish and Parks Spec. Rep. No. 27. Denver, Colo. 21 p.

5E-64 U.S. Environmental Agency. 1973. Effect of noise on wildlife and other animals. EPA, Office of Noise Abatement and Control. Spec. Rep. Washington, D.C. 9 p.

5E-65 Walchek, K. C. 1970. Nesting bird ecology of four plant communities in the Missouri River Breaks, Montana. Wilson Bull. 82(4):370-382.

5E-66 Wiens, J. A. 1969. An approach to the study of ecological relationships among grassland birds. Ornithol. Monogr. 8:1-93.

5E-67* Williams, L. G. 1962. Plankton population dynamics. (See 3E-52).

5E-68-A Yoakum, J. 1972. Antelope-vegetative relationships. Trans. 1972 Interstate Antelope Conf.

Estimated pronghorn populations were plotted according to North American vegetative communities. Some 62% lived in grassland; 37% in grassland-brushlands; and 1% in desert.

(Abstracted by Sally Ralston).

VI. GENERAL RECLAMATION

A. Measured or Potential Impact of Coal Strip Mining on the Environment

6A-1 Atwood, G. 1975. The strip mining of western coal. Sci. Am. 222(6):23-29.

6A-2 Austin, R. L., and P. Borrelli (Eds.). 1971. The stripmining of America: An analysis of surface coal mining and the environment. Sierra Club, New York, N.Y.

6A-3-A Bass, A., J. R. Mahoney, and B. L Murphy. 1976. Impact of significant deterioration proposals upon western surface coal mining operations. Rep. No. ERT-P-2125-1a. Environmental Res. and Technol. Inc., Concord, Mass., and Office of Energy Conserv. and Environment, Federal Energy Admin. Washington, D.C. 59 p. (NTIS PB-253 254/7ST).

Proposed significant deterioration of air quality provisions currently under consideration by Congress in the Clean Air Act Amendments of 1976 has potential impact on the nature, extent and location of future industrial development throughout the U.S., including the use of national energy resources. This report addresses the impact of the proposed amendments upon western surface coal mining, and in particular, the constraints upon coal strip mining activities which may arise because of fugitive dust emissions.
(From NTIS).

6A-4-A Beach, B. A. 1973. Strip mining and reclamation in Kentucky, 1972. Presented at Industrial Coal Conf., Univ. Kentucky, Lexington, 12-13 April. 6 p.

This paper reviews the background of mining in Kentucky and discusses specifically the impact of strip mining on the environment. In 1966 the General Assembly passed a strip mining law. This article outlines the programs conducted in cooperation with Appalachian Regional Commission and the U.S. Environmental Protection Agency, U.S. Corps of Engineers, U.S. Forest Service, and the U.S. Soil Conservation Service. The article also describes how the Kentucky Reclamation Division enforces the law, levies penalties, and issues permits. Detailed figures are given on strip-mined acreage explaining the great growth of this industry in Kentucky, the number 1 coal producing state.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-11, p. 80).

6A-5-A Bergoffen, G. S. 1962. Strip-mine reclamation: A digest. U.S. Forest Serv., USDA, Washington, D.C. 49 p.

This is a review and summary of published reclamation literature through mid-1961. Most of the reclamation research up to that time was being carried out in the eastern U.S., but some of the results and conclusions are applicable in the western states. The coverage includes a discussion of the characteristics of spoils and the influences these have on revegetation, selection of plant species and methods of planting, potential uses of strip-mined lands, and mining methods used. The stringency and administration of state strip-mine reclamation legislation is reviewed.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

6A-6-A Bourke, R. L. 1975. The Montana energy policy study and the Fort Union Coal Basin, p. 392-409. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 4. Eastern Montana Coll., Billings.

The current and projected production of coal in Montana is examined in detail. Water limitations and the pro's and con's of present and future coal development are discussed.

Specific problem areas are given: (1) Reclamation potentials of arid valleys and plains have not been proven. (2) The westward shift of coal industry will result in well documented socioeconomic disruptions in both the East and West. (3) There is some dispute over the necessity of going west for the low sulfur coal required for power plants to meet the federal performance standards. (4) The lower cost estimates are based on two fragile assumptions concerning the cost of mining western coal and installation of scrubbers.

The socioeconomic problems involved with western coal resource development are analyzed, considering both the benefits and costs of the western shift. Suggested policies and their implementations are presented.

(Abstracted by Sally Ralston).

6A-7* Brant, R. A. 1964. Geological description and effects of strip mining on coal overburden material.

(See 1A-4-A).

6A-8 British Columbia Research. 1973. Environmental analysis of Sarpy Creek Coal Development. British Columbia Res., Vancouver, B.C., and Somer's Land Company, Helena, Mont.

6A-9 Brown, R. 1970. Pit or park. Sierra Club Bull. 55:8-11.

6A-10 Buckley, R. E., and P. F. Zimmer. 1974. Open pit mining: A review of the past five years. Mining Congr. J. 60(2): 30-35.

6A-11 Bukro, C. 1972. Strip mining and its impact on the state of Illinois. Chicago Tribune. 26 March: Sect. 1, p. 4; 27 March: Sect. 1, p. 16; 28 March: Sect. 2, p. 7; 29 March: Sect. 2, p. 9; 30 March: Sect. 2, p. 15.

6A-12 Bureau of Indian Affairs. 1973. Crow ceded area coal lease Westmorland Resources mining proposal: Draft environmental statement. Planning Support Group, Bureau of Indian Affairs, USDI, Billings, Mont. 246 p.

6A-13 Charmbury, H. B. 1973. Conservation of natural resources: Surface mining in Pennsylvania. Coal: Today and Tomorrow 19(4):23-25.

6A-14 Conaway, J. 1973. The last of the West: Hell, strip it! Atl. Monthly 232(3):91-103.

6A-15-A Council of State Governments. 1964. Conservation and land use in the surface coal mine industry. (Mined Land Conservation Conference, "Surface mining: Extent and economic importance, impact on natural resources, and proposals for reclamation of strip-mined lands"). Council of State Governments RM Publ. No. 369. Chicago, Ill. 64 p.

This booklet contains several speeches given at the Conference of Surface Mining in Roanoke, Virginia, April 13-14, 1964: "Surface mining-minerals, metals and divots," by Julian W. Friss; "Some pertinent Water Resources Division studies in acid mine drainage problems by U.S. Geological Survey," by Arnold E. Lamm; "The Open Cut Land Reclamation Act in Illinois," by E. E. Filer; a statement by George F. Deasy to the Subcommittee on Minerals, Materials and Fuels Relative to S.1013; "The New Land," by Paul N. Seastrom, and a presentation by G. Don Sullivan to the American Bar Association. These speeches discussed laws, enforcement, history of strip mining, and current reclamation.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R64-4, p. 24).

6A-16* Deasy, G. F., and P. R. Griess. 1959. Coal strip pits in the northern Appalachian landscape.

(See 1B-8).

6A-17 Deasy, G. F., and P. R. Griess. 1960. Terrain damages resulting from bituminous coal stripping in Pennsylvania. Pa. Acad. Sci. Proc. 34:124-130.

6A-18 Deasy, G. F., and P. R. Griess. 1961. Stripped and breaker wastelands of the anthracite region. Pa. Acad. Sci. Proc. 35:129-136.

6A-19 Department of Health and Environmental Services. 1972. Environmental impact statement on the proposed Montana Power Company electric generating plant at Colstrip, Montana. Dep. Health Environmental Serv., State of Montana, Helena. 44 p.

6A-20 Department of the Interior. 1975. Draft environmental impact statement: Kaiparowits Project. Bur. Reclamation and Bur. Land Manage., USDI, Washington, D.C.

6A-21* Doerr, A. H. 1961. Coal mining and landscape modification in Oklahoma.

(See 1B-10).

6A-22-A Dudley, T. E., and J. L. Becker. 1974. Mined land reclamation on the Northern Great Plains, Indian Head Mine. Am. Mining Congr. Convention/Exposition, 7-10 October, Las Vegas, Nev. 14 p.

The climate, soils, geology, hydrology, vegetation, and wildlife of the Northern Great Plains region are described. In summarizing the mining and reclamation projects of the North American Coal Corp., it is pointed out that for about three years reclamation has been carried out on 3 acres for every acre mined. Reclamation research is also being carried out at the mine by USDA Agricultural Research Service, North Dakota State Univ., and Montana Agricultural Experiment Station.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R74-33, p. 120).

6A-23 Dusek, G. L. 1974. Bull Mountain coal field study. Rep. 11. Montana Dep. Fish & Game (Helena) and Consolidation Coal Co. 76 p.

6A-24 Dusek, G. L., and S. A. McCann. 1973. Bull Mountain coal field study. Rep. 1. Montana Dep. Fish & Game (Helena) and Consolidation Coal Co. 53 p.

6A-25 Fosher, D. 1976. The impact of strip mining on the Western Great Plains. J. Am. Soc. Farm Manage. Rural Apprais. 40(1):67-70.

6A-26-A Gill, T. J. 1972. Coal development potential of eastern Montana. Environmental Quality Council, State of Montana, Helena.

The author discusses available resources, present and future development, and impact from increased coal production.
(From R. K. Honkala. 1974 bibliography. No. 183).

6A-27 Gillespie, W. H. 1964. Effects of coal strip mining in West Virginia. West Virginia Univ., Morgantown. (Typewritten).

6A-28 Gould, W. L., and V. W. Howard. 1975. Biotic composition and soil characteristics of an area to be surface mined in San Juan by El Paso Natural Gas Company. New Mexico Agric. Exp. Sta. Special Rep. 24-2. New Mexico State Univ., Las Cruces. 31 p.

6A-29-A Gwynn, T. A. 1969. An improved environment through intelligent mined-land reclamation. Presented at Rocky Mountain Minerals Conf., 17-19 September, Am. Inst. Mining Eng. Salt Lake, Utah. 31 p. (Preprint No. 69-F-343).

Summarizes recent legislation in field of mined-land reclamation, stressing that mining companies must cooperate in securing just, realistic reclamation laws.
(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

6A-30 Gwynn, T. A. 1972. Environmental implication of developing our coal reserves. Earth Sci. Bull. 5(4):17-29.

6A-31 Hannah, H. W., and B. Vandervliet. 1939. Effects of strip mining on agricultural areas in Illinois and suggested remedial measures. J. Land Public Utilities Econ. 15(3):296-311.

6A-32 Hodder, R. L. 1975. Montana reclamation problems and remedial techniques, p. 90-106. *In* M. K. Wali (ed.) Practices and problems of land reclamation in western North America: Symposium. Univ. North Dakota Press, Grand Forks.

6A-33 Jarret, A. E. 1968. Resources, reclamation and recreation: the Ohio Power Company and the 3 R's. Am. For. 74(11):28-29,47-49.

6A-34-A Jemison, G. M. 1965. Mined area restoration of tomorrow. J. Soil Water Conserv. 20(4):186-188.

This article forecasts the condition which may exist 35 years hence when coal usage will be 2 1/2 times what it is now. The author predicts revegetation problems will be solved by the year 2000 and restored mined areas will become valuable suburban centers.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R65-11, p. 32).

6A-35 Joseph, A. M., Jr. 1971. The murder of the Southwest. Audubon 73(4):52-67.

6A-36 Klimstra, W. D., and S. R. Jewell. 1973. Strip mining resources in conflict, impacts and reclamation efforts in Illinois, p. 121-131. *In* J. B. Trefethen (ed.) Transactions of the 38th North American Wildlife and Natural Resources Conference. Vol. 4. Wildl. Manage. Inst., Washington, D.C.

6A-37 Krivak, J. A. 1961. Strip mining by a real conservationist. Water, Land, and Life 3(1):10-12.

6A-38 Mason, G. L. 1968. Stripping Kentucky: The subversive poor. Nation 207(23):721-724.

6A-39 McDougall, W. B. 1925. Forest and soils of Vermillion County, Illinois with special reference to the striplands. Ecology 6(1):372-379.

6A-40* McWhorter, D. B., et al. 1974. Potential of mine and mill spoils for water quality degradation.
(See 3A-19).

6A-41 North Dakota Academy of Sciences. 1973. The environmental impact of strip mining in North Dakota. North Dakota Geol. Surv. Educ. Ser. No. 5. North Dakota Acad. Sci., Grand Forks.

6A-42-A Northeastern Forest Experiment Station. 1969. Black diamonds and green vistas. Northeast. For. Exp. Sta., U.S. Forest Serv. 14 p.

An illustrated booklet outlining the problems incurred by strip mining and ways in which the USDA Forest Service is tackling them. This is a general and superficial account.

(Abstracted by Sally Ralston).

6A-43-A Northern Great Plains Resources Program. 1975. Effects of coal development in the Northern Great Plains: A review of major issues and consequences at different rates of development. Northern Great Plains Resources Program, Denver Fed. Center, Denver, Colo.

This document details (1) the coal resources of the Northern Great Plains; (2) energy development in the Northern Great Plains; (3) land, water, and air resources of the Northern Great Plains, examining each separately, with detailed discussions of the rehabilitation prospects and coal development impacts. Water receives special consideration due to the large economic value and lack of the resource in the area; (4) economic, social and cultural impacts of coal development in the Northern Great Plains. Specific sections under this heading are: the principal impact on communities and changes expected; impact on Indians as a result of coal development; agriculture-present setting and impact assessment; societal and cultural impacts.
(Abstracted by Sally Ralston).

6A-44-A Plass, W. T. 1966. Land disturbances from strip-mining in eastern Kentucky. 1. Upper Cumberland coal reserve district. U.S. Forest Serv. Res. Note NE-52. Northeast. For. Exp. Sta., Berea, Ky. 7 p.

A survey, using aerial photography, of the geology and physiography of a coal reserve district in Kentucky, the extent of stripping and the distribution of stripped areas.
(Abstracted by Sally Ralston).

6A-45-A Plass, W. T. 1967. Land disturbances from strip-mining in eastern Kentucky. 2. Princess coal reserve district. U.S. Forest Serv. Res. Note NE-55. Northeast. For. Exp. Sta., Berea, Ky. 8 p.

Results of an aerial photography survey show the extent and distribution of strip mining areas in one of the six coal reserve districts in eastern Kentucky. Physiography, geology, and forest cover of the area are described.
(From author's abstract).

6A-46-A Plass, W. T. 1967. Land disturbances from strip-mining in eastern Kentucky. 3. Licking River coal reserve district. U.S. Forest Serv. Res. Note NE-68. Northeast. For. Exp. Sta., Berea, Ky. 6 p.

Results of an airplane survey to determine the extent of land disturbance by coal mining and coal haul roads in one of the six coal reserve districts in eastern Kentucky. Describes the district, forest cover, physiography and geology, and distribution and characteristics of the 1456 acres disturbed in the 1 million acre district. (From author's abstract).

6A-47-A Plass, W. T. 1967. Land disturbances from strip-mining in eastern Kentucky. 4. Big Sandy coal reserve district. U.S. Forest Serv. Res. Note NE-69. Northeast. For. Exp. Sta., Berea, Ky. 7 p.

Results of an airplane survey to determine the extent of land disturbance by coal strip mining and by coal haul roads in one of the six coal reserve districts of eastern Kentucky. Describes the district, forest cover, physiography, and physical characteristics of the acres disturbed in the district.
(From author's abstract).

6A-48-A Plass, W. T. 1967. Land disturbances from strip-mining in eastern Kentucky. 5. Hazard coal reserve district. U.S. Forest Serv. Res. Note NE-71. Northeast. For. Exp. Sta., Berea, Ky. 7 p.

Results of an airphoto survey to determine the extent of land disturbances by coal mining and by coal haul roads in one of the six coal reserve districts of eastern Kentucky. Describes the district, forest cover, physiography and geology, and distribution and physical characteristics of the acres disturbed in the district. (From author's abstract).

6A-49-A Plass, W. T. 1967. Land disturbances from strip-mining in eastern Kentucky. 6. Southwestern coal reserve district. U.S. Forest Serv. Res. Note NE-72. Northeast. For. Exp. Sta., Berea, Ky. 8 p.

Results of an airphoto survey to determine the extent of land disturbances by coal mining and coal haul roads in one of the six coal reserve districts in eastern Kentucky. Describes the district, forest cover, physiography and geology, and distribution and physical characteristics of the acres disturbed in the district.
(From author's abstract).

6A-50 Plummer, A. P. 1965. Observations of strip mining in Montpelier and Soda Springs District, Caribou National Forest. National Forest File No. 1440. U.S. Forest Serv., Washington, D.C.

6A-51-A Rankin, B. 1966. A second look at surface mining. Consol News 5(1):2-7.

The author points out several beneficial effects of strip mining to the land.
(Abstracted by Sally Ralston).

6A-52-A Sandoval, F. M., J. J. Bond, J. F. Power, and W. O. Willis. 1973. Lignite mine spoils in the Northern Great Plains: Characteristics and potentials for reclamation, p. 117-133. *In* First Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

Spoils from strip mining for lignite and subbituminous coal in North Dakota, Montana, and Wyoming were studied in the laboratory and in the field to evaluate their potential for reclamation and revegetation. Results show that the physiochemical properties of the materials provide a very poor environment for vegetative growth. Materials from the Tongue River and Sentinel Butte Formations within the Fort Union group were often extremely fine-textured, moderately saline, and highly sodic. Severity of the problems associated with high clay and high adsorbed sodium content increase with depth from the original surface. Low organic matter combined with fine texture enhances the sodium dispersion effect which renders the spoil materials extremely unstable, highly impermeable, and erodible to water. Available phosphorus in spoil materials was very low. Available nitrogen depended on the age of the exposed spoils. Treatments showing promise for reclamation include fertilization (especially phosphorus) in combination with the use of topsoil, vegetative (straw) mulches, and possibly gypsum as a calcium amendment, although response to gypsum in field studies has been disappointingly slow.
(Authors' abstract adapted).
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-129, p. 104-105).
(See also Bond et al. 2A-9-A).

6A-53 Schneider, B. 1973. The big sacrifice. Mont. Outdoors 4(1):12-26.

6A-54 Sindelar, B. W. 1973. Certain ecological analyses and information for study areas A, B, C, D, and E in the vicinity of Colstrip, Montana. Animal and Range Sciences Dep., Montana State Univ., Bozeman.

6A-55* Spaulding, W. M., Jr., and R. D. Ogden. 1968. Effects of surface mining on the fish and wildlife resources of the United States.
(See 3C-69-A).

6A-56-A Student Intercession Project. 1973. An ecological-economic study of strip mining in southeastern Ohio. Unpubl. Student Intercession Rep. Case Western Reserve Univ., Cleveland, Ohio.

This report examines the need for coal, alternative schemes of mining, the reasons for mining in southeastern Ohio, biological effects of stripmining, reclamation needs and techniques, and reclamation objectives.
(From Dalsted and Leistritz. 1973 bibliography. No. H-1, p. 32).

6A-57-A Tennessee Dep. of Conservation and Commerce. 1960. Conditions resulting from the strip mining of coal in Tennessee. Tennessee Dep. Conserv. Commerce, Knoxville, Tenn., and Tennessee Valley Authority. 13 p.

This booklet is essentially a picture presentation of strip mining and reclamation. A survey of strip mined areas was conducted by the state of Tennessee and TVA and results of this survey are summarized. A map shows the principal strip mines in Tennessee by counties.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R60-2, p. 13).

6A-58-A Tennessee Valley Authority. 1963. An appraisal of coal strip mining. TVA, Knoxville, Tenn. 13 p.

Gives an outline of the problems caused by mining and the history of reclamation by TVA, under the headings: grading, reforestation, recreation, wildlife, agriculture, and costs.
(From British bibliography, unpubl., p. 54).

6A-59* Thompson, W. W. 1969. Cover establishment on strip-mined area using two rhizomatous grass species.
(See 4B-34-A).

6A-60-A Trawick, J. 1971. Strip mining. Environmental J., Natl. Parks Conserv. Mag. 45(7):11-14.

The author gives the conservationist's concern for the physical impact of strip mining on the environment.
(Abstracted by Sally Ralston).

6A-61-A Trimble, G. R., Jr. 1963. Hybrid poplar grows poorly on acid spoil banks at high elevations in West Virginia. U.S. Forest Serv. Res. Note NE-7. Northeast. For. Exp. Sta. 4 p.

The Northeastern Station started this program in 1951-52 on acid spoil banks from strip mining in Northern West Virginia at an elevation of about 3,500 ft. The spoils were compacted and were made up of sandstone, shale and large amounts of coal and rock fragments. Plantings were made on limed and unlimed plots. Survival and growth on unlimed blocks were poor, averaging 20 percent after three seasons. Although lime treatment had a favorable effect it was concluded that hybrid poplars should not be planted on sites with difficult growing conditions.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R63-20, p. 23).

6A-62-A Wali, M. K. (Ed.). 1973. Some environmental aspects of strip mining in North Dakota. Educational Ser. 5. North Dakota Geol. Survey, Univ. North Dakota, Grand Forks. 121 p.

A collection of papers wherein the authors discuss analysis of spoil material, ecology of mined areas, economics of stripping and reclamation, and North Dakota controls and reclamation laws.

(From R. K. Honkala. 1974 bibliography. No. 442).

6A-63 Walter, G. H. 1949. Agriculture and strip coal mining. Agric. Econ. Res. 1(1):24-29.

6A-64-A Water Resources Research Institute. 1973. Coal-energy development in the Northern Great Plains. Special Advisory Comm., Water Resources Res. Inst., Univ. Wyoming, Laramie. 114 p. (NTIS PB-231 560/4WE).

Reclamation needs and work in progress are among the concerns summarized in this study which is a part of the Northern Great Plains Resources Program. The program is designed to provide information on the impacts of coal development on the region.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-32, p. 84).

6A-65-A Wayman, C. H. 1975. Proceedings of regional energy EIS seminar, held at Denver, Colorado on 6-7 March. Denver Fed. Executive Board, Colo. 174 p. (NTIS PB-255 268/5ST).

Because of the impetus of energy development projects in the Rocky Mountain area, a seminar was held in Denver, Colorado, on March 6-7, 1975, to address the multitude of environmental impacts (both on-site and off-site) that might result. The meeting was devoted to both technical and legal aspects of the problem. It specifically addressed problems in the energy-related environmental impact statement process.
(From NTIS).

6A-66-A Wells, J. R. 1953. The reclamation of strip mined areas in southeastern Kansas. Trans. Kansas Acad. Sci. 56:269-292.

A review is given of the current progress made in attempts to establish different types of vegetation on strip mined land in Kansas, which appears to be capable of maintaining a wide range of different plant types. Leveling of spoil banks does not seem to be necessary for successful establishment of trees or pasture species and effective establishment can be obtained immediately after the completion of mining operations. A number of tree species apparently grow successfully on such areas, but the establishment of pastures appears to be the most practicable means of utilizing large areas of spoil banks.
(From Herbage Abstr. 25).

6A-67 Westinghouse Environmental Systems. 1973. Colstrip generation and transmission project: Applicant's environmental analysis. Westinghouse Environmental Systems.

B. Potentials of Spoils for Revegetation

6B-1 Allman, M. 1965. The ultimate use of stripmined land, p. 51-62. *In* Proceedings of the Conference on Interaction of Urbanization and Mineral Industries. Natural Resources Inst., Ohio State Univ., Columbus.

6B-2* Anonymous. 1970. Reclamation under semiarid conditions. (See 1A-1-A).

6B-3 Bookhout, T. A., et al. 1968. Potential of a strip mined area for fish and wildlife reclamation. Ohio State Univ. Res. Foundation, Ohio State Univ., Columbus.

6B-4 Box, T. W. (Chairman). 1974. Rehabilitation potential of western coal lands. Natl. Acad. Sci. and Ballinger Publ. Co., Cambridge, Mass.

6B-5* Brohard, E. 1962. Strip revegetation. (See 2A-12-A).

6B-6-A Dickman, I. J. 1964. The strip mine reclamation program in Ohio. Ohio J. Sci. 64:165-168.

This article is a review of Ohio's reclamation laws and the use of coal strip mine areas. Lakes formed by the end-cut of strip mine parallels have been found to be excellent habitat for fish. (From Dalsted and Leistritz. 1973 bibliography. No. E-14, p. 17).

6B-7* Dusek, G. L. 1975. Vegetational responses by substrate, gradient, and aspect on a twelve acre test plot in the Bull Mountains. (See 4D-3-A).

6B-8 Environmental Protection Agency. 1971. Mine spoils potentials for water quality and controlled erosion. Water Pollut. Control Ser., Project No. 14010-EJE for EPA. Div. Plant Sci., West Virginia Univ., Morgantown.

6B-9 Fitton, A., H. J. Gibbons, G. Precious, J. Weber, and G. H. Theobald. 1959. Experiments on rehabilitation of opencast coal sites. Exp. Husb. 4:58-73.

6B-10* Grubb, H. F. 1965. The feasibility of vegetating mine tailing at Climax, Colorado. (See 4A-65-A).

6B-11-A Knabe, W. 1962. The reclamation of lands stripped for brown coal. Ohio Agric. Exp. Sta. Ser. 49. Forestry Dep., Ohio State Univ., Columbus. 11 p. [Transl. from German and condensed by M. P. Koller].

When test holes are drilled to determine the quality, quantity, and faults of the coal in a coal field, overburden data are recorded. This information is used to determine the mining procedure so that the better soils will be put back on the surface when mining is complete. Twenty-two tests giving useful information on soil quality are listed. Of these, nine were found to supply adequate information on the potential agricultural value of each layer of the overburden.

The reasons for hostile conditions on old mine banks and successful methods of revegetation thereof are given.

(From British bibliography, unpubl., p. 43).

6B-12* Krause, R. R. 1973. Predicting mined land soil potential. (See 2A-42-A).

6B-13-A Limstrom, G. A., and G. H. Deitschman. 1951. Reclaiming Illinois strip coal lands by forest planting. Univ. Illinois Agric. Exp. Sta. Bull. 547. Univ. Illinois, Urbana. 50 p.

Character and extent of strip coal lands; site conditions in five strip mining districts; forest planting possibilities, experiments and recommendations; and a review of the literature are included in this review of reclamation in Illinois. Classifications of strip mined lands and chemical analyses of strata over coal seams are tabulated in the appendix.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R51-1, p. 5).

6B-14-A Limstrom, G. A., and R. W. Merz. 1949. Rehabilitation of lands stripped for coal in Ohio. Central States For. Exp. Sta. Tech. Pap. No. 113. U.S. Forest Serv. (Columbus, Ohio). 41 p.

This booklet describes the character and extent of strip mined lands in Ohio, including age classes of spoils, diversity of site conditions, and rehabilitation problems. A section of the publication describes planting and seeding experiments, and effects of acidity, slope, and aspect on survival and growth. Considerable tabulated data are included with a list of specific planting recommendations and the performance data on each species of tree in the test project. An appendix shows coal seams involved and description and chemical analyses of the cover on each seam.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R49-3, p. 4).

6B-15 Miller, E. W. 1949. Strip mining and land utilization in western Pennsylvania. Sci. Monthly 69(2):94-105.

6B-16 National Academy of Sciences. 1974. Rehabilitation potential of western coal lands: A report to the Energy Policy Project of the Ford Foundation. Ballinger Publ. Co., Cambridge, Mass. 198 p.

6B-17-A Packer, P. E. 1974. Rehabilitation potentials and limitations of surface mined land in the Northern Great Plains. U.S. Forest Serv. Gen. Tech. Rep. INT-14. Intermountain For. and Range Exp. Sta., Odgen, Utah.

An emerging environmental quality problem in the Northern Great Plains (NGP) is the rehabilitation of the spoils left in the wake of mining coal deposits. Important factors influencing the potentials for growing vegetation on different kinds of land are: (1) amount and distribution of precipitation; (2) soil productivity and stability; and (3) suitability and availability of plant materials for rehabilitation processes.

These factors are the basis for the classification of surface minable lands. These areas of land have been names "rehabilitation-response units."

Approximately 86 different kinds of rehabilitation response units involving 146 different areas of land comprise the surface minable lands of the NGP.

The results of actual rehabilitation efforts in the area are described and discussed as to the problems and successes encountered, both in methodology and economics. Information and research needs are listed.

(From author's abstract).

6B-18-A Plass, W. T. 1975. Reclamation of surface mined land. Ohio J. Sci. 75(6):298-304.

Past accomplishments demonstrate that the disturbances from surface mining have a potential for management and development. Chemical and physical characteristics of the overburden need to be characterized to plan an efficient and profitable mining operation that complements a reclamation program designed to achieve an appropriate land management objective.

Includes a review of the basic concepts and procedures that apply to reclamation methods used in the United States.

(From author's abstract).

6B-19 Power, J. F., W. O. Willis, F. M. Sandoval, and J. J. Bond. 1974. Can productivity of mined land be restored in North Dakota? Farm Res. 31(6):30-32.

6B-20-A Roseberry, J. L., and W. D. Klimstra. 1964. Recreational activities on Illinois strip-mined lands. J. Soil Water Conserv. 19(3):107-109.

The authors detail the current use of the more than 108,000 acres of strip-mined lands in the state and they describe the recreational use now being made of stripped areas.

(From Dalsted and Leistritz. 1973 bibliography. No. E-52, p. 23).

6B-21 Ruffner, J. D. 1965. Some aspects of wildlife habitat development in spoil mine reclamation. Presented at Coal Mine Spoil Reclamation Symp. (October), School For., Coll. Agric., Pennsylvania State Univ., University Park.

6B-22* Sandoval, F. M., et al. 1973. Lignite mine spoils in the Northern Great Plains: Characteristics and potential for reclamation.

(See 6A-52-A).

6B-23 Sawyer, L. E. 1949. The use of surface mined land. J. Soil Water Conserv. 4(4):161-165,170.

6B-24-A Smith, R. M., E. H. Tryon, and E. H. Tyner. 1971. Soil development on mine spoil. West Virginia Agric. Exp. Sta. Bull. 604T. West Virginia Univ., Morgantown. 47 p.

The long-range potential of coal spoils for revegetation was studied by comparison with 70- to 130-year-old iron ore spoils.

(Abstracted by Sally Ralston).

6B-25 Thurn, E. A. 1953. The potentialities of revegetation and utilizing agronomic species on strip mined land in Illinois. 6th Year Progr. Rep. Illinois Agric. Exp. Sta. and Illinois Coal Strippers Assoc. 48 p.

6B-26-A Truax, C. N., Jr. 1965. Water storage potential of surface mined coal lands. Mining Congr. J. 51(11):40-41, 45-46.

This article explains how strip mine cast overburden serves as a valuable water reservoir in dry periods. Indiana University scientists made a study of this condition and found that during dry periods, creeks in unmined areas were dry whereas this was not the case in the mined sections. The study was made in southwestern Indiana, an area which suffers from chronic floods and droughts.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R65-23, p. 34).

6B-27 U.S. Department of Interior. 1967. Surface mining and our environment. A special report to the Nation. U.S. Government Printing Office, Washington, D. C. 124 p.

6B-28 Whitt, D. M. 1970. After the mining, useful land. Mining Congr. J. 56(5):27-29.

6B-29 Wilson, H. A. 1951. Strip mine spoils: They can be reclaimed. W. Va. Agric. Exp. Sta. Bull. 349(1):8-9.

6B-30* Yeager, L. E. 1942. Coal-stripped land as a mammal habitat with special reference to fur animals.
(See 5A-26).

C. Revegetation Efforts and Research

6C-1 Abdnor, J. S. 1968. Environmental controls: Land reclamation. Mining Congr. J. 1968(Dec):54 p.

6C-2 Anderson, D., L. P. Hamilton, H. G. Reynolds, and R. R. Humphrey. Reseeding desert grassland ranges in southern Arizona. Arizona Agric. Exp. Sta. Bull. No. 249. Arizona State Univ., Tempe. 32 p.

6C-3-A Anonymous. 1956. Reclaiming a pit heap. Colliery Eng. 33:501-506.

An account of the reclamation of colliery spoil which has been used to fill clay pits at Brickershaw, Abram. The spoil was ameliorated with lime and fertilizer but soil was not brought onto the site. After cultivation the spoil was sown at 45 lb./acre with 12% Italian ryegrass S22, 14% perennial ryegrass S23, 50% locksfoot S143, 8% timothy S48, 10% creeping red fescue S59, and 6% early red clover S151. After two years the sward supported a herd of grazing cows and reclamation was considered to be successful.
(From British bibliography, unpubl., p. 20).

6C-4-A Anonymous. 1964. Operation Green Earth. Coal Age 69(1):43.

The article describes the Peabody Coal Company's program for developing strip mined lands.
(Abstracted by Sally Ralston).

6C-5* Anonymous. 1970. Reclamation under semiarid conditions. (See 1A-1-A).

6C-6-A Appalachian Regional Commission. 1969. Surface mine reclamation, p. 97-114. *In* C. W. Rice & Co. (ed.) Acid mine drainage in Appalachia: Engineering economic study of mine drainage control techniques, Pittsburgh, Pa. (Appendix B). Appalachian Regional Comm., Washington, D.C.

Describes the replanting of surface mine spoils.
(Abstracted by Sally Ralston).

6C-7 Berg, W. A. 1971. Vegetative stabilization of mine waters in Colorado. Progress Rep. Dep. Agron., Colorado State Univ., Fort Collins. 44 p.

6C-8-A Box, T. W. 1973. The energy crisis and the fate of strip mined lands. Utah Sci. 34(4):117-120.

Dr. Box headed the National Academy of Science Study Committee that reported on "The Potential for Reclamation of Surface-Mined Lands in the Western United States"; he summarizes the finding of the report.
(From R. K. Honkala. 1974 bibliography. No. 794, p. 77).

6C-9 Boyd, S. P. 1967. Mine scarred land reclamation study. City Planning Commission, Scranton, Pa. 18 p.

6C-10-A Brock, S. M., and D. B. Brooks. 1968. The Myles Job Mine: A study of benefits and costs of surface mining for coal in northern West Virginia. Res. Ser. 1. Appalachian Center, Office of Res. and Development. West Virginia Univ., Morgantown. 61 p.

This is a detailed cost study of all items pertaining to mining, acid drainage, and reclamation for the Myles Job Mine which produced 47,000 tons of coal--a rather small operation. Very detailed descriptions are given on acid control and spoil bank material handling and revegetation. The cost analysis is tabulated in two appendices.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R68-3, p. 44).

6C-11 Brown, G. T. 1949. Strip mining and land restoration. Soil Conserv. 15(5):107-109.

6C-12 Bruce, R. 1957. Problems of land reclamation. 4. Open cast coal sites. Agric. Rev. (London) 2(9):30-35.

6C-13 Campbell, W. I. D. 1961. The restoration of open cast coal sites in life. Scott. Agric. 41:66-69.

6C-14 Capp, R. T. 1967. A land and water reclamation program. Mining Congr. J. 53(8):106-108.

6C-15 Carnes, W. G. (Ed.). 1966. Landscape reclamation. Landscape Architecture 56(2):113-114.

6C-16 Caudill, H. M. 1973. Farming and mining. Atl. Monthly 232(3):85-90.

6C-17-A Chapman, A. G. 1949. Progress in stripped land regeneration research, p. 309-315. *In* American Mining Congress Yearbook. Am. Mining Congr.

General appraisal of conditions, especially the effects of water supply and compaction following grading.
(From British bibliography, unpubl., p. 32).

6C-18 Collinson, L. E. 1967. Land restoration in Northumberland after opencast coal. Agriculture (London) 74:489-494.

6C-19 Conway, E. Preliminary report of the Mining and Reclamation Conference. Ohio Univ. Res. Inst., Ohio Univ., Athens. (Mimeo).

6C-20-A Cooper, J. E. 1970. Field trials on colliery spoil in West Riding of Yorkshire. Presented at Proc. North England Soils Discussion Group 6. Leeds, 1969. (Available from H. T. Davies, Soil Science Dep., NAAS, Government Bldgs., Lawnswood, Leeds (£1.25)).

Field trials were carried out to determine the value of limestone, shoddy, sewage sludge, NPK, pfa, and organifax as ameliorants on colliery spoil at three sites in Yorkshire. Seed mixtures of grasses, clovers, and legumes were used. The results show that treatment such as pfa and broiler manure, which do not raise the substrate pH higher than the control, can still produce yield significantly in excess of the control. The results also demonstrated that some spoils can be revegetated without the use of topsoil.

(From British bibliography, unpubl., p. 21).

6C-21-A Curtis, W. R. 1971. Vegetating strip-mine spoils for runoff and erosion control, p. 40-41. *In* Proceedings on Revegetation and Economic Use of Surface Mined Land and Mine Refuse Symposium. Pipestem State Park, W. Va.

The functions and methods of vegetating strip mine spoils are discussed generally.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R71-10, p. 56).

6C-22-A Czapowskyj, M. M. 1969. Anthracite coal-mine spoils today: Forests tomorrow. Pa. For. 59(3):81-83. (Available from Northeastern Forest Experiment Station, 204 Centerstreet, Berea, Kentucky 40403).

A brief review of the work of the U.S. Forest Service on the afforestation of strip mined land in Pennsylvania, with a summary of the results of research to date.

(From British bibliography, unpubl., p. 34).

6C-23-A Darmer, G. 1963. Restoring overburden surfaces to cultivation as an ecological problem and planning of landscape management. Oikos 14(2):248-266. (In German).

Reclamation of acid sand and of dumped and flurrially transported loess overburden removed during mining operations using rye, various grasses, and legumes as pioneer crops, is discussed.

(From Herbage Abstr. 34).

6C-24-A Davies, W. M. 1961. Land restoration following mineral extraction and deposition of waste materials. J. R. Agric. Soc. Engl. 122:26-38.

The reclamation of waste sites with or without topsoil replacement is described using grass-legume leys composed of Italian ryegrass, perennial, red clover, alsike clover, and white clover (with other species including chicory) or pure lucerne leys or brassica crops. High levels of nitrogen are essential and a covering of 12 inches of soil is desirable. In general, grazing should be withheld for the first few years.
(From Herbage Abstr. 33).

6C-25-A Davies, W. M. 1963. Bringing back the acres: Opencast coal. Agriculture (London) 70:133-138.

Drains should be installed and kept running freely. Grass is usually the first crop and the land is limed at 2.3 tons/acre and often subsoiled by deep rooting machines or modified mole plow. Generous manuring is essential and poaching by animals should be avoided in wet weather. For arable crops following grass, manuring should be generous.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 16).

6C-26* Davis, G. 1970. Research on revegetation and hydrology of surface mined areas.
(See 4B-5-A).

6C-27 Dean, F. W. 1965. The reclamation of stripped coal lands. J. For. 23 (7-8):677-682.

6C-28 Deane, J. A. 1962. Reclamation and water control of stripped coal mines, p. 8-19. *In* Engineering Ser. Bull. 54. Univ. Missouri Engineering Exp. Sta., Univ. Missouri, Columbia.

6C-29-A Deasy, G. F., and P. R. Griess. 1963. Coal strip mine reclamation: An approach to the problem. Mechanization 27(12):27-31. Also in Mineral Industries 33(1):1, 3-7.

The strip mining problems, methods of treating stripped lands and results, implications of recent trends in stripped land, legislation, and some problems associated with specialized renovation of stripped lands are discussed.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R63-4, p. 20).

6C-30 Dietrich, C. C. 1971. Mined land reclamation in the western U.S. Rocky Mt. Mineral Law Inst. 16:143-205.

6C-31 Dollhopf, D. J., and M. E. Majerus. 1975. Stripmine reclamation research located at Decker Coal Company, Decker, Montana: Progress Report. Res. Rep. 83. Mont. Agric. Exp. Sta., Montana State Univ., Bozeman. 42 p.

6C-32 Farmer, E. E., R. W. Brown, B. Z. Richardson, and P. E. Packer. 1974. Revegetation research on the Decker coal mine in southeastern Montana. U.S. Forest Serv. Res. Pap. INT-162. Intermountain For. Range Exp. Sta., Ogden, Utah. 12 p.

6C-33 Finn, R. F. 1958. Ten years of strip mine forestation research in Ohio. Central States For. Exp. Sta. Tech. Pap. 153. U.S. Forest Serv. (Columbus, Ohio). 38 p. Also in Wildl. Rev. 94:30. (Abstr.).

6C-34-A Frank, R. M. 1963. A guide for screen and cover planting of trees on anthracite mine-spoil areas. U.S. Forest Serv. Res. Note NE-22. Northeast. For. Exp. Sta., Upper Darby, Pa. 50 p.

Areas disturbed by coal mining in Pennsylvania were mapped and potential planting sites necessary to screen them from view or cover them were delineated. Number of seedlings needed for a planting program was estimated. Areas shown on maps were classified according to kind of spoil, density of present tree cover, and visibility. Maps were prepared for major communities, counties, and for the entire anthracite region.

(From Forest Service abstract).

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R63-5, p. 20).

6C-35-A Furneaux, A. A. 1971. The restoration of agricultural land where opencast mining is to take place or where land is to be disturbed for the purposes of laying large diameter pipes. 6 p. (Typescript). (Available for consultation at Univ. College Swansea, Wales).

Notes on the examination of the site before working, the preservation of top and subsoil, use of filling materials to restore the original ground level, the treatment to restore soil structure and the importance of using fertilizers, especially organic ones.

(From British bibliography, unpubl., 38).

6C-36-A Garner, R. V. 1953. Revegetation of strip-mined areas in Oklahoma. Proc. Okla. Acad. Sci. 34:208-209.

This article explains the fact that Oklahoma has no reclamation law like many other states and for this reason, the Forestry Department, state universities, and the Soil Conservation Service have combined to try some experiments. The project established the fact that the spoil areas had adequate moisture but were deficient in nutrients. Most Oklahoma spoil areas are suitable for forests. Black locust and evergreens have been found to grow best especially for Christmas tree, fence post, mine prop and pulp wood production. Selective planting and thinning gives trees of highest quality. Near Tulsa, overburden areas are being used for industrial purposes as the most valuable use.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R53-1, p. 6).

6C-37 Gilmore, J. S., and M. K. Duff. 1974. A growth management case study: Sweetwater County, Wyoming. Univ. Denver Res. Inst., Denver, Colo.

6C-38-A Graham, M. 1973. Reclamation of spoil lands. I. Technical, p. 207-218. *In* M. Graham. A natural ecology. Manchester Univ. Press, Manchester, England.

Author's experience of reclamation of derelict land, especially coal spoil, by volunteers in the north of England.

(From British bibliography, unpubl., p. 21).

6C-39 Grandt, A. F. 1965. Reclamation for pasture and agricultural crops, p. 124-128. *In* Proceedings of Coal Mine Spoil Reclamation Symposium. Pennsylvania State Univ., University Park.

6C-40 Grandt, A. F. 1967. Advantages of reclamation: Agricultural crops. Proc. Strip Mining Symp., Owensboro, Ky. 5 p.

6C-41-A Grim, E. C., and R. D. Hill. 1974. Environmental protection in surface mining of coal. Environmental Protection Technol. Ser. EPA-670/2-74-093. EPA, Washington, D.C. 277 p.

This comprehensive report covers all phases and problems of the strip mining operation, including premining planning, sediment and erosion control, reclamation, and acid mine drainage. A glossary of terms and a summary of state surface mining and reclamation laws in effect June 1, 1974 are also included.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R74-41, p. 121-122).

6C-42 Guernsey, L. 1958. Reclamation of strip-mined lands in Vigo County, Indiana. Indiana Acad. Sci. Proc. 67:215-224.

6C-43 Guernsey, L. 1960. The reclamation of stripmined land in western Kentucky. J. Geogr. 59(1):5-11.

6C-44 Gwynn, T. A. 1965. Rehabilitation of lignite areas of North Dakota following surface mining. Knife River Coal Mining Co., Bismarck, N.D. 15 p. Also published in 1967, p. 129-137. *In* C. C. Zimmerman and S. Russell (eds.) Symposium on the Great Plains of North America. North Dakota Inst. for Regional Studies, Fargo.

6C-45* Gwynn, T. A. 1966. Reclaiming strip-mined lands by establishing game management areas--A progress report. (See 4D-5-A).

6C-46-A Gwynn, T. A. 1972. A quality environment can be maintained while stripmining Montana's coal. Presented at Upper Missouri Water Users Conf., 1 December 1972.

Presents reclamation goals and techniques from a coal mining company's point of view. (Abstracted by Sally Ralston).

6C-47 Hall, H. N. 1940. The romance and reclamation of the coal lands in southeastern Kansas. Kansas Acad. Sci. Trans. 43:57-67.

6C-48 Harman, N. M. 1957. Some aspects of strip mine reclamation. Yale Conserv. Stud. 6:39-43.

6C-49-A Hill, R. D. 1969. Reclamation and revegetation of strip-mined lands for pollution and erosion control. Am. Soc. Agric. Eng. Pap. No. 69-705. ASAE, St. Joseph, Mo. (Available from ASAE, P.O. Box 229, St. Joseph, MO. 49085).

In excess of 3.2 million acres of land have been disturbed by surface mining in the U.S. These lands present unique pollution and erosion problems. This paper reviews mining practices and how they create these problems. Current reclamation practices are reviewed and detailed information is given on a large (700 acre) reclamation project in West Virginia. (From author's abstract).

6C-50-A Hill, R. D. 1973. Reclamation and revegetation of 640 acres of surface mines--Elkins, West Virginia, p. 417-450. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 2. Gordon and Breach, New York, N.Y.

The demonstration project was started in 1964. The control measures include air sealing and underground mine; water diversion; burying of acid-producing material; regrading and revegetation. There was some improvement in water quality. Weeping lovegrass and European alder were the species most successfully established.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-65, p. 92).

6C-51 Hodder, R. L., and R. G. Atkinson. 1974. Peabody Coal Company big sky reclamation research. Res. Rep. 48. Montana Agric. Exp. Sta., Montana State Univ., Bozeman. 46 p.

6C-52-A Hodder, R. L., B. W. Sindelar, et al. 1972. Coal mine land reclamation research: Progress report, 1971. Res. Rep. 20. Montana Agric. Exp. Sta., Montana State Univ., Bozeman. 42 p.

The overall objective of the study is to reduce the undesirable effects of coal strip mining and restore or create a desirable and productive environment in the shortest time feasible.

(From Dalsted and Leistritz. 1973 bibliography. No. E-28, p. 19-20).

6C-53* Hodder, R. L., and B. W. Sindelar. 1972. Coal mine land reclamation research located at Decker, Montana.
(See 4A-73-A).

6C-54 Hodder, R. L., and B. W. Sindelar. 1972. Progress in reclamation research in Montana. Misc. Rep. 11. Montana Agric. Exp. Sta., Montana State Univ., Bozeman. 12 p.

6C-55 Holmes, L. A. 1944. Reclaiming stripped land in Illinois. Sci. Monthly 49(6):414-420.

6C-56 International Union for Conservation of Nature and Natural Resources. 1956. The rehabilitation of areas biologically devastated by human disturbance, p. 119-150. *In* Proc. of Sixth Technical Meetings of the Int. Union for Conservation of Nature and Natural Resources, Edinburgh.

6C-57 Jewell, S. L. 1964. Conservation of strip mine lands. Mining Congr. J. 50:38-39.

6C-58 Johnson, E. A. 1965. Research in strip mine reclamation, p. 11-18. *In* Proceedings, symposium on stripmine reclamation, Lexington, Ky. Ky. Dep. Nat. Resources, Frankfort.

6C-59 Klock, G. 1973. Mission Ridge: A case history of soil disturbance and revegetation of a winter sports area development. U.S. Forest Serv. Res. Note PNW-199. Pacific Northwest For. Exp. Sta., Portland, Ore. 10 p.

6C-60 Knabe, W. 1962. The reclamation of lands stripped from brown coal.
(See 6B-11-A).

6C-61-A Knudsen, L. L., and P. H. Struthers. 1953. Stripmine reclamation in Ohio. Ohio J. Sci. 53(6):351-355.

The history of reclamation and general appraisal of situation. Reclamation Association established in 1940. They used air photos to map areas affected by strippings. Trees, forage, and shrub plantings were used. High acidity of toxic spoils were associated with high level of Fe, Al, Mn, Zn, Cn, Co, Ni, and Pb. Analyses of high walls and the spoils derived from them will be used to guide the reclamation of new spoils.
(From British bibliography, unpubl., p. 44).

6C-62 Kohnke, H. 1950. The reclamation of coal mine spoils. Adv. Agron. 2:317-349.

6C-63 Lane, R. D. 1968. Forest Service reclamation research. Mining Congr. J. 54:38-42.

6C-64-A Limstrom, G. A. 1964. Revegetation of Ohio's strip-mined land. Ohio J. Sci. 64:112-119.

An account of the revegetation of strip mined land in Ohio, describing site conditions and stressing the importance of site preparation and selection of suitable species from an appropriate seed source.
(From British bibliography, unpubl., p. 45).

6C-65-A Loomis, T. H. W. 1970. Current reclamation programs in the western United States, p. 161-180. *In* W. C. Pebers (ed.) Mining and ecology in the arid environment. Coll. Mines, Univ. Arizona, Tucson.

This paper is from the Bureau of Land Management, Denver Service Center, Bldg. 50, Denver Federal Service, Denver, Colorado 80225. This agency has solo jurisdiction over all resources on 450 million acres of federal lands. In addition they manage the mineral resources on another 350 million acres of federal lands and 62 million acres under public land laws as stockraising homesteads. The paper describes the operation of the Bureau and its land use policy. A number of slides were included in this paper but only their explanation is given.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R70-9, p. 52).

6C-66* Lujan, L. E. 1966. Revegetation of strip-mined areas in southwestern Wyoming.
(See 4B-18-A).

6C-67-A Maneval, D. R. 1972. Coal mining vs. environment: A reconciliation in Pennsylvania. Appalachia 5(4):10-40.

Discusses Pennsylvania mining controls, repair of land damage, mine drainage, backfilling and associated problems.

(From R. K. Honkala. 1974 bibliography. No. 436, p. 43).

6C-68-A May, M. 1967. Mine reclamation in the western states. Mining Congr. J. 53:101-105.

Reviews problems and research findings as to mined-land reclamation in the western United States. The major problems of this area are lack of moisture and selection of desirable plant species adaptable to revegetation of the area. Diversity of problems and need for study are emphasized.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

6C-69-A May, M., et al. 1971. Reclamation of strip mine spoil banks in Wyoming. Res. J. 51. Wyoming Agric. Exp. Sta., Univ. Wyoming, Laramie. 32 p.

The publication is a collection of all available research results on reclamation of Wyoming strip mine spoil banks. The main emphasis of the study was placed in the Kemmerer Coal Mines. The three types of experiments conducted were (a) tree planting (using various species, fertilizer, and irrigation), (b) grass seeding (using four species and various means of holding moisture), and (c) transplanting sod chunks and sprigs of two rhizomatous species with different means of holding moisture.

(From Dalsted and Leistritz. 1973 bibliography. No. E-42, p. 21).

6C-70 Merkel, D. L., J. W. Hale, and P. L. Sims. 1973. Performance of seeded grasses in northwestern Colorado. Colorado Agric. Exp. Sta. Gen. Ser. 926. Colorado State Univ., Fort Collins. 13 p.

6C-71-A Miles, V. C., R. W. Ruble, and R. L. Bond. 1973. Performance of plants in relation to spoil classification in Pennsylvania, p. 13-31. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 2. Gordon and Breach, New York, N.Y.

The use of the spoil classification which is based mainly on pH, slope, and stoniness is demonstrated, also the performance of the major grass, legume, shrub and tree species used in Pennsylvania is summarized.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-90, p. 97).

6C-72 Mined Land Conference. 1969. Reclamation's greatest year. Mined-Land Conserv. Conf. Proc. 5(1).

6C-73 Montana Energy Advisory Council. 1974. Coal development information packet. Montana Energy Advisory Council, Helena.

6C-74-A National Agricultural Advisory Service. 1968. Annual report of opencast coal restoration for 1968. Natl. Agric. Advisory Serv., South Wales area. 3 p. (Typescript).

Discusses drainage and management of restored opencast coal sites. Poultry litter from a broiler house has been used as an organic amendment.
(From British bibliography, unpubl., p. 45).

6C-75-A National Agricultural Advisory Service. 1969. Annual report of opencast coal restoration for 1969. Natl. Agric. Advisory Serv., South Wales area. 4 p. (Typescript).

Discusses drainage, management and annual programme for restored opencast coal sites.
(From British bibliography, unpubl., p. 45).

6C-76-A National Agricultural Advisory Service. 1970. Annual report of opencast coal restoration for 1970. Natl. Agric. Advisory Serv., South Wales area.

Discusses drainage and management problems which resulted from a year of wet weather.
(From British bibliography, unpubl., p. 46).

6C-77-A Nephew, E. A. 1972. Healing wounds. Environment 14(1): 12-21.

West Germany has been successful in reclaiming the land of strip mines in its brown coal region. Although costs are high, mined land is restored to productive use, and displaced residents are resettled in planned communities.
(From R. K. Honkala. 1973 bibliography. No. 633, p. 63).

6C-78-A Northeastern Forest Experiment Station. (Year unknown). Revegetate strip-mined land. Forestry Sci. in the Service of Man, No. 15. Northeast. For. Exp. Sta. U.S. Forest Serv. (Upper Darby, Pa.). 4 p.

The brief report describes the efforts of Forest Service research teams to revegetate strip mine spoil. The recommended three steps to successful revegetation are (1) fertilizing, (2) grass and legume seeding, and (3) tree planting. The emphasis is on stopping erosion, site protection, and esthetics.
(Abstracted by Sally Ralston).

6C-79-A Paller, W., and D. A. Schultz. 1973. Planning approaches to surface mining on the national forests, p. 68-81. *In* First Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

Phosphate mining in Caribou National Forest, Pocatello, Idaho, is discussed and related to the general problems of strip mining. An administrative study by the Forest Service and four members of the Phosphate Mining Industry considered reclamation of areas already mined and made plans for future mining to minimize effects of disturbing land. Surface mining is also considered in relation to multiple use of an area with nonrenewable resources and to its impact on such factors as timber production, wildlife needs, water quality, fisheries, and groundwater supplies.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-102, p. 99).

6C-80 Peplow, E. H. 1970. Western mining's hand restoration efforts. Mining Congr. J. 1970(Sept.):58-63.

6C-81-A Peterson, E. B., and H. M. Etter. 1970. A background for disturbed land reclamation and research in the Rocky Mountain region of Alberta. Information Rep. A-X-34. Forest Res. Lab., Canadian Forest Serv., Edmonton, Alberta. 45 p.

A very useful report dealing with strip mine or surface disturbances such as road cuts, quarries and large rock slides. The literature to date is reviewed. The need for determining after use of land before mining begins is stressed. The factors which should be considered in determining and achieving the objectives are given. Recommendations and suggestions for future use are made. Has a bibliography of 90 references.
(From British bibliography, unpubl., p. 12).

6C-82 Plummer, A. P., D. R. Christensen, and S. B. Monsen. 1968. Restoring big game range in Utah. Utah Div. Fish. and Game Pub. No. 68-3. Salt Lake City, Utah.

6C-83 Pniower, G. 1956. Cultivation of spoil dumps and pit heaps of lignite opencast mining in Nieder-Lausitz, p. 136-138. *In* Proceedings of 6th Technological Meetings. Int. Union for the Conservation of Nature and Natural Resources, Edinburgh.

6C-84 Potter, H. S., S. Weitzman, and G. R. Trimble, Jr. 1951. Reforestation of strip-mined lands in West Virginia. Northeast. For Exp. Sta. Pap. No. 43. U.S. Forest Serv. (Berea, Ky.). 28 p.

6C-85 Pringle, J. 1959. Opencast coal mining: the restoration problem, p. 64-72. *In* Proceedings of the 1958 International Symposium of Soil Structure.

6C-86 Pugsley, E. B., C. Y. Cheng, D. M. Updegraff, and L. W. Ross. 1970. Abatement of mine drainage pollution in the Rocky Mountains. Study in restoration environment. Univ. Denver No. 1:1-18.

6C-87-A Ratcliffe, A. J. B. 1964. Opencast coal restoration, South Wales. Natl. Agric. Advisory Serv. Exhibit, Br. Ecol. Soc. Conversazione. Swansea, Wales, April 1964. 2 p. (Typescript).

Illustrates the work of the NAAS on restoration of opencast coal sites. It covers restoration on lowland sites and management and the restoration programme for upland sites and finance.
(From British bibliography, unpubl., p. 48).

6C-88 Reclamation Research Staff. 1975. Progress report: Research on reclamation of strip mined lands in the Northern Great Plains. USDA Agric. Res. Serv., Mandan, N.D., and North Dakota Agric. Exp. Sta., Fargo. 20 p.

6C-89-A Reilly, J. D. 1965. Planning surface mine reclamation before mining. Mining Congr. J. 51(11):93-96.

This report concerns Hanna Coal Division's work and planning of reclamation activities in southeastern Ohio. Forage crops and reforestation of reclaimed land is their main concern.
(From Dalsted and Leistritz. 1973 bibliography. No. E-50, p. 22).

6C-90-A Research Committee on Coal Mine Spoil Revegetation in Pennsylvania. 1965. A guide for revegetating bituminous strip mine spoils in Pennsylvania. USDA Soil Conservation Service, Hamburg, Pa. 46 p. (Available from V. E. Miles, USDA Soil Conservation Service, Box 985, Federal Sg. Sta., Hamburg, Pa. 17108).

A comprehensive guide covering (1) characteristics and classification of spoils, (2) revegetation planning, before and after strip mining, (3) reclamation for woodland, (4) reclamation for agricultural uses, (5) reclamation for wildlife (suitable species, availability of stock, quality and care of stock, planting methods and seasons, planting guide for wildlife development), (6) reclamation for recreational use, and (7) multiple use reclamation.
(From British bibliography, unpubl., p. 49).

6C-91 Riley, C. V., and J. A. Rinier. 1972. Reclamation and mine tip drainage in Europe, p. 1-14. *In* C. J. Potter (ed.) 4th Symp. on Coal Mine Drainage Research. Coal Ind. Advisory Comm. to Ohio River Valley Water Sanitation Commission, Mellon Inst., Pittsburgh, Pa.

6C-92-A Robinson, D. H. 1945. Reclaiming pit mounds. Agriculture (London) 52:178-180.

Reclamation of land covered with spoil from shallow coal workings has been carried out successfully in Worchestershire. The spoil heaps were bulldozed into the holes, and then sugar beet waste lime, ground lime, and dried sewage sludge were spread over the area and disced in. Initial seeding with ryegrass was largely unsuccessful but animals were allowed to graze on the plants that did survive. Later a cover was successfully established by drilling broadcasting seed and applying fertilizer. Fertilizers were triple super phosphate, ammonium phosphate, ammonium sulfate, and basic slag.
(From British bibliography, unpubl.).

6C-93 Sawyer, L. E. 1948. Reclamation and conservation of stripped overlands. Mining Congr. J. 32:32-36.

6C-94 Sawyer, L. E. 1953. Strip mining solves its water problems. Coal Mine Modernization (1953):413-414.

6C-95 Schavilje, J. P. 1941. Reclaiming Illinois strip mined coal lands with trees. J. For. 39:714-719.

6C-96-A Schessler, T. E. 1964. Strip-mine reclamation: A digest. Eastern Region Coop. and Soil Conserv. Soc. Am., U.S. Forest Serv., Washington, D.C. 69 p.

This revision brings up-to-date the summary of strip mine legislation and includes several new references.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R64-[illegible], p. 29).

6C-97-A Schessler, T. E., and R. F. Droege. 1965. Strip-mine reclamation: A digest. J. Soil Water Conserv. 20(1):17-20.

Acidity and aging of spoils, grading of spoil banks, plant nutrients and microclimatry afforestation of spoils, use of strip mined lands and mining methods are discussed.

(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 2).

6C-98 Sindelar, B. W., R. L. Hodder, and M. E. Majerus. 1973. Surface mined land reclamation research in Montana: Progress report 1972-1973. Res. Rep. No. 40. Montana Agric. Exp. Sta., Montana State Univ., Bozeman. 122 p.

6C-99-A Sindelar, B. W., R. Atkinson, M. E. Majerus, and K. Proctor. 1973. Surface mined land reclamation research at Colstrip, Montana: Progress report 1973-1974. Res. Rep. No. 69. Montana Agric. Exp. Sta., Montana State Univ., Bozeman. 98 p.

Montana law requires reclamation to provide "suitable permanent diverse vegetative cover" and allows no more soil erosion than would have occurred before mining. Precipitation in the area averages 15 inches/year and weather conditions vary widely and can be severe. Studies to aid in developing successful reclamation methods under these conditions include methods of soil manipulation to improve water retention; evaluation of establishment of trees, grasses, shrubs, and legumes over several growing seasons; topsoil depth and gradient studies; comparison of fertilized mined lands with fertilized native range; and a rodent population survey on areas used in vegetative studies.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-136, p. 106).

6C-100-A Smith, H. G, H. H. Morse, G. E. Bernath, L. E. Gillogly, and W. M. Briggs. 1964. Classification and revegetating of strip-mine spoil banks. Ohio J. Sci. 64(2):168-175.

The Soil Conservation Service assists landowners in solving land use problems including those on strip mine spoil land. A mapping system classifying soils on strip mined land has been developed by soil scientists. Spoil material is further classified, on the basis of the pH, stoniness and steepness of area, for the purpose of making vegetative plantings, whose recommendation depends on the suitable or chosen land. Plants are being tested in field trials on strip mine spoils to further define their tolerance for adaptability on these critical areas.

(From author's abstract).

6C-101-A Stearn, E. W. 1964. Surface mining's conservation program pays off. Coal Mining Process. 1(4):22-26, 47.

The Mined Land Conservation Conference was formed in 1965 to encourage sound reclamation programs. Examples are given of research in several states including the Ayreshire and Pittsburg and Midway Coal companies successful farming activities.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R64-33, p. 29).

6C-102-A Stefanko, R., R. V. Ramani, and M. R. Ferko. 1973. An analysis of strip mining methods and equipment selection. Res. Development Rep. No. 1, Interim Rep. No. 7 to U.S. Office of Coal Res., Pennsylvania State Univ., University Park. 134 p.

This report reviews all methods and equipment used for strip mining. Although considerable emphasis is placed on specific items of mining equipment, there is also particular reference to reclamation and proper methods of waste disposal. Many sketches and diagrams show the ways to handle overburden and proper methods of building spoil areas. Diagrams also show how to handle the water problem and how to locate artificial lakes.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-141, p. 107).

6C-103-A Sullivan, G. D. 1967. Current research trends in mined-land conservation and utilization. Mining Eng. 19(3):63-67.

A review of the research on mined-land reclamation currently underway by the coal industry. The work is centered principally in the eastern states with some interest and research starting in the Midwest, North Dakota, and Wyoming. Areas of interest include revegetation, soil chemistry (spoils), hydrology, and earth movement.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

6C-104-A Sutton, P. 1970. Restoring productivity of coal mine spoilbanks. Ohio Rep. Res. Development 55(4):62-63.

A brief report on the research carried out at the eastern Ohio Agricultural Research and Development Center to determine methods for use in reclaiming toxic spoil materials. Techniques tested are the use of different depths of topsoil cover and use of limestone, mulch, and subsoil. Experiments were also set up to determine how leaching of spoil affects pH and soluble salts. Results

so far indicate that soluble salts decrease but pH does not alter appreciably. Present research is to determine the effect of leaching acid and salts out of toxic spoil banks on the establishment of vegetation.
(From British bibliography, unpubl., p. 53).

6C-105 Switzer, K. B. 1969. Revegetation of some North Dakota lignite strip mine spoil banks. M.S. Thesis. Univ. North Dakota, Grand Forks. 65 p.

6C-106 Thirgood, J. V. 1969. Land disturbance and revegetation in Canada. Can. Mining J. 1969(Dec.):3-7.

6C-107-A Thirgood, J. V. 1969. Production and reclamation planning: Kaiser Resources Ltd. Presented at Proc. 21st Canadian Conferences on Coal, 9-11 September. Calgary, Alberta.

Report of the work of Kaiser Resources Ltd., describing their production and reclamation planning. (Intended to serve as guide to other mining companies.)
(From British bibliography, unpubl., p. 54).

6C-108 Touenges, A. L. 1939. Reclamation of stripped coal land. Rep. of Investigations No. 3440. Bur. Mines, USDI, Washington, D.C.

6C-109-A Tresler, R. L. 1974. Strip mine reclamation in Wyoming, p. 22-28. *In* Second Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Louisville, Ky.

Reclamation in the coal area of southwestern and south central Wyoming, the uranium area of Shirley Basin and the Gas Hills, the bentonite area of the Big Horn Basin, the Black Hills bentonite area, and the Powder River Basin is described in detail. Mining and reclamation of the Kemmerer Coal Company are used as an example in the southwestern and south central region, and the activities of Pacific Power & Light Co., Amax Coal Co., and Big Horn Coal Co. in the Powder River area. The contribution of the Soil Conservation Service has been in preparing soil maps showing soil characteristics and suitability and in developing planting methods and plant materials. A revegetative technique also being tried is transferring shrubs and associated soil from areas to be mined into an area to be reclaimed.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. 74-101, p. 134-135).

6C-110 Tryon, E. H., R. M. Smith, and S. L. Galpin. 1948. Reclamation of strip mined areas of West Virginia. Am. Soc. Agron. J. 40:313-323.

6C-111-A U.S. Department of Agriculture. 1968. Restoring surface mined land. Misc. Publ. 1082. U.S. Dep. Agric., Washington, D.C. 17 p.

The extent of surface damage from mining is briefly reviewed. Tabulations are presented showing acreage of damaged land by commodity, mining methods, state, ownership, age of mines, etc. Various aspects of the damage are considered - onsite and offiste effects. Accomplishments in reclamation, land treatment, research, and legislation are reviewed.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

6C-112 Vande Linde, O. V., Jr. 1969. Reclamation progress in West Virginia. Presented at Am. Mining Congr., 7 May, Pittsburgh, Pa.

6C-113* Vimmerstedt, J. P. 1970. Stripmine reclamation: 22 years of continuing research.

(See 4B-37-A).

6C-114 Walter, G. H. 1950. Recent experience in rehabilitation of stripped lands. J. Farm Econ. 32:277-282.

6C-115-A West Virginia Department of Natural Resources. 1969. Reclamation handbook. Div. Reclamation, Dep. Nat. Resources, Charleston, W. Va. 64 p.

A handbook of the Acts relating to surface mining and reclamation. Section 6 (p. 42-60) deals with revegetation of worked land, recommending spoil treatment, choice of species, and planting methods. Approved woodland mixtures are listed and their uses on different types of spoil are indicated.

(From British bibliography, unpubl., p. 56).

6C-116 Wheeler, W. H. 1965. Progress in reclamation with forest trees, p. 111-116. *In* Proc. Coal Mine Spoil Reclamation Symp. Pennsylvania State Univ., University Park.

6C-117-A Zarger, T. G. 1966. Coal strip mining in Tennessee. Keep Tennessee Green J. 6(3):3 pp.

A brief historical account of the growth of coal mining in Tennessee, resulting in the necessity for reclamation, and laws to insure that reclamation is carried out when mining operations are finished.

(From British bibliography, unpubl., p. 58).

D. General Reclamation Research

6D-1 Brock, S. M. 1971. Prepared statement. Testimony presented before Ohio House of Representatives' Committee on Natural Resources and the Environment. 16 March, Columbus, Ohio. (Mimeo).

6D-2-A Coltharp, G. B., C. W. Cook, and I. B. Jensen. 1965. Methods and techniques for seeding roadway cuts and fills on interstate systems in Utah. Annu. Proj. Rep. and Work Plan, Proj. No. 684. Utah Agric. Exp. Sta., Utah State Univ., Logan.

This study was initiated in 1965, at various Interstate Highway locations throughout the state of Utah. Some of the topics covered are: effect of mulches and fertilizers on seedling establishment; effect of drill types on seedling establishment; species adaptability; and use of pre-emergent and post-emergent herbicides in weed control for seedling establishment. Plots are identified and specific treatments discussed.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

6D-3-A Dean, K. C., R. Havens, and K. T. Harper. 1969. Chemical and vegetative stabilization of a Nevada copper porphyry mill tailing. Rep. of Investigations No. 7261. Bur. Mines, USDI, Washington, D.C.

Tests were made on stabilizing windblown tailings at McGill, Nevada. Legumes, winter wheat, wheatgrasses, and wild rye were seeded and protected with a resinous adhesive chemical until sprouting. Annual precipitation is about eight inches, strong winds common and tails were slightly basic (pH 7.3 to 7.5). Fertilizer was used; no irrigation. Costs are estimated at about $135 per acre and probably could be reduced.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

6D-4-A Federal Water Pollution Control Administration. 1966. Disposition and control of uranium mill tailing piles in the Colorado River Basin. HEW, Washington, D.C.

This report is a survey of mill tailings at idle and active uranium mills in the Colorado River Basin: western Colorado, eastern Utah, northeast New Mexico, and northwest Arizona. Long-range health hazard potential and possible pollution of groundwaters are considered. Treatment methods are recommended and costs estimated.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

6D-5 Gates, D. H. 1962. Revegetation of a high altitude, barren slope in northern Idaho. J. Range Manage. 15:314-318.

6D-6-A Gordon, I. M. 1969. Erosion control at Hollinger mine tailing site. Can. Mining J. 1969(June):46-49.

This discusses establishing a vegetative cover on mill tailings (pH 7.0 to 7.4) at Timmons, Ontario by the Hollinger Consolidated Gold Mines, Ltd. Fertilizer rates, seedings, and grass species are listed. A novel aspect is use of sewage sludge on one area; highly successful. Scrub trees are planted as windbreak and conifers will be planted in subsequent years for future timber.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

6D-7-A Grandt, A. F. 1974. Reclamation problems in surface mining. Mining Congr. J. 60(8):29-32.

The problems of reclamation including overburden analysis, climate, and precipitation are discussed along with the creation of lakes and reservoirs.

(Abstracted by Sally Ralston).

6D-8* Grubb, H. F. 1965. The feasibility of vegetating mine tailing at Climax, Colorado.

(See 4A-66-A).

6D-9-A Gwynn, T., et al. 1971. Report of the land reclamation task force. North Central Power Study, March 1971. 16 p.

The report is divided into two major sections: mined land reclamation and pipeline right-of-way reclamation. The report is general in scope. The states toward which the report is directed include Montana, North Dakota, Wyoming, and Arizona.

(Abstracted by Sally Ralston).

6D-10-A Honkala, R. A. 1974. Surface mining and mined land reclamation. Old West Regional Commission, Washington, D.C. 154 p. (Available from Old West Regional Commission, 1730 K Street, N.W., Suite 426, Washington, D.C. 20006).

A selected bibliography emphasizing the literature pertinent to western surface coal mining and the reclamation thereof. It contains 1337 references. Sections include: Surface mining and distribution of land and water, Reclamation, Revegetation, and Extensive reference list for revegetation of sand dunes and arid areas.

(Abstracted by Sally Ralston).

6D-11 Kieffer, F. V. 1971. The status of stripmining in Ohio. Ohio Conservation Foundation, Worthington. (Mimeo).

6D-12 Kochanowsky, B. J. 1965. The coal stripping operation, p. 72-76. *In* Proceedings of Coal Mine Spoil Reclamation Symposium. School For., Coll. Agric., Pennsylvania State Univ., University Park.

6D-13-A Loomis, T. H. W. 1971. Compiled research data on reclamation of disturbed lands in the western United States, 1970. Bur. Land Manage., USDI, Washington, D.C. 18 p.

A bibliography of 41 research reports dealing with the reclamation of disturbed land in the western states. A list of reclamation projects by states is included. (From "Conference on mining and ecology in arid environments," 22-27 March 1970, Tucson, Ariz.).
(Abstracted by Sally Ralston).

6D-14* May, M. 1967. Mine reclamation in the western states.
(See 6C-70-A).

6D-15-A Montana Coal Task Force. 1973. Coal development in eastern Montana. Montana Dep. Nat. Resources and Conserv., Helena. 80 p.

This is a situation report which covers many facts of ongoing coal development in Montana. Major areas of concern are: state coal leasing policy, coal mining methods, reclamation of mined-land, water resources, air and water quality, fish and wildlife, economic and social impacts, land use, and highways.
(From Dalsted and Leistritz. 1973 bibliography. No. H-29, p. 35).

6D-16 North Dakota Agricultural Experiment Station. 1974. Special issue on coal development. North Dakota Agric. Exp. Sta. Farm Res. 31(6):48 p.

6D-17-A Pfleider, E. P. (Ed.). 1972. Surface mining. Seeley W. Mudd Ser. Am. Inst. Mining Eng., New York, N.Y.

Contains chapters on coal mining by J. D. Reilly, land reclamation by L. E. Sawyer, and brown coal mining in western Germany by W. Tillman.
(Abstracted by Sally Ralston).

6D-18-A Pulver, J. A., and B. J. Polich. 1975. Energy development in the Rocky Mountain region: Goals and concerns. Fed. of Rocky Mountain States, Inc., Denver, Colo. 134 p.

The social, political, and economic aspects of energy development are discussed.
(Abstracted by Sally Ralston).

6D-19 Richardson, B. Z., E. E. Farmer, R. W. Brown, and P. E. Packer. 1975. Rehabilitation research and its application on a surface mined area of eastern Montana, p. 247-265. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 3. Eastern Montana Coll., Billings.

6D-20* Semotan, J. 1962. Application of knowledge on soil-forming processes for reclamation of industrial wastes. (See 2A-69-A).

6D-21-A Stark, N. 1966. Review of highway planting information appropriate to Nevada. Univ. Nevada, Coll. Agric. Bull. No. B-7. Univ. Nevada, Reno.

The ecological factors involved are briefly summarized. Criteria for various types of plantings are given: intensive-beautification, intermediate, nonintensive, erosion control, and miscellaneous. The problems related to highway plantings are discussed; many of these are applicable to revegetation of any disturbed area. Weed control, need for seed information and sources, water and fertilizer requirements, various mulches and other special problems are considered. Highway planting programs of other states are reviewed. A detailed list of plants is given by vegetation zones. Soil and moisture requirements, insect and disease resistance, seed source and general characteristics of each plant are listed.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

6D-22-A Stewart, R. E., Jr. 1975. New energy research in the fish and wildlife service, p. 81-86. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 1. Eastern Montana Coll., Billings.

Present programs of the Biological Services Programs are described, giving their short- and long-term objectives. Structure, staffing, and budgets of the program are given.

Upland ecosystem projects include: (1) geothermal project, (2) western water allocation, (3) oil shale project, and (4) coal project.

(Abstracted by Sally Ralston).

6D-23-A Striffler, W. D. 1967. Restoration of open cast coal sites in Great Britain. J. Soil Water Conserv. 22(3):101-103.

A report on open cast coal reclamation after a visit to the British coal fields. Reclamation of open cast coal land is compared with strip mine reclamation in the United States.

(From British bibliography, unpubl., p. 52).

6D-24 Thilenius, J. F., and G. B. Glass. 1974. Surface coal mining in Wyoming: Needs for research and management. J. Range Manage. 27:336-341.

6D-25* U.S. Department of Agriculture. 1968. Restoring surface-mined land.
(See 6C-111-A).

6D-26 Upper Colorado Region State-Federal Interagency Group. 1971. Upper Colorado Region, comprehensive framework study. Upper Colorado Region, State-Federal Interagency Group.

6D-27 Van Swearington, H. 1975. Reclamation requirements may not be achievable. Billings Gazette, 12 March.

VII. HUMAN COMPONENTS

A. Economics

7A-1 Albright, T. A. 1971. The hidden costs of strippmining: A socio-economic study of Belmont County, Ohio. Case Western Reserve Biol. 933 Interseason Proj. Ohio State Univ., Cleveland. (Mimeo).

7A-2 Alonso, W. 1971. The economics of urban size. Papers of the Regional Sci. Assoc. 26:61-76. (Regional Sci. Assoc., Philadelphia, Pa.).

7A-3* Anderson, B. 1975. A study of the impacts of reduced streamflows in the middle and lower Yellowstone Basin. (See 3E-1-A).

7A-4 Bowman, M. J., and W. W. Haynes. 1963. Resources and people in east Kentucky: Problems and potentials of a lagging economy. Johns Hopkins Press, Baltimore, Md.

7A-5-A Brooks, D. B. 1966. Strip mine reclamation and economic analysis. Nat. Resources J. 6(1)13-44.

The author suggests that a rational allocation of resources (value of minerals vs. social costs resulting from extraction) can be made based on benefit-cost analysis. Goals used are national productivity, cultural and aesthetic values, and local employment (redistribution of income).

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

7A-6-A Brooks, D. B. 1966. Strip mining, reclamation and public interest. Am. For. 72:51-57.

In this general description of strip mining and reclamation, advantages of strip mining are emphasized and the increase in total stripped coal over the years is noted. Benefit-cost analysis as related both to mining and to reclamation is discussed.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R66-1, p. 36).

7A-7-A Dalsted, N. L., F. L. Leistritz, and T. A. Hertsgaard. 1975. Economic impact of coal development in western North Dakota, p. 480-492. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 4. Eastern Montana Coll., Billings.

The estimates presented indicate that coal-energy development is likely to cause major economic changes in areas with extensive and readily recoverable coal reserves. Modest levels of coal development may assist some areas in reversing a trend of economic decline. Higher levels of development, however, will place considerable pressure on public service delivery systems and may impose substantial social costs on present residents.

To avoid the disruptive aspects of coal development, public officials and planners should give serious attention to alternative means of providing and financing public services. At the national level, attention should be given to developing alternative energy sources.

(From author's summary).

7A-8 Dalsted, N. L., F. L. Leistritz, et al. 1974. Economic impact of alternative energy development patterns in North Dakota. Final report prepared for the Northern Great Plains Resource Program. Dep. Agric. Econ., North Dakota State Univ., Fargo.

7A-9 Dinkel, R. M., and J. L. Guernsey. 1968. An economic appraisal of reclamation practices on a strip coal mine site in Greene County, Indiana. Proc. Indiana Acad. Sci. 78:201.

7A-10 Graham, H. D. 1948. The economics of strip coal mining: with special references to Knox and Fulton Counties, Illinois. Bureau of Economic and Business Res. Bull. 66. Univ. Illinois, Urbana.

7A-11-A Guernsey, L. 1955. Strip mining: A problem in conservation. J. Geol. 54:174-182.

Deals with the economic and sociological effects of strip mining.

(Abstracted by Sally Ralston).

7A-12 Hertsgaard, T. A., and F. L. Leistritz. 1973. Environmental impact of strip mining: The economic and social viewpoint, p. 73-86. *In* The environmental impact of strip mining in North Dakota. North Dakota Geol. Surv. Educ. Ser. 5. North Dakota Acad. Sci., Grand Forks.

7A-13-A Higgins, T. 1973. The planning and economics of mined-land use for agricultural purposes, p. 287-293. *In* First Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

The experience of Peabody Coal Company shows users that strip mined land can be restored successfully to agricultural use. Problems with toxic soil can be reduced by mining methods, soil treatment, and choice of plants for seeding. After the reclaimed land has been revegetated, its use depends on its relation to other land in the same area. By company policy, the agricultural land is organized into family farm units. Beef cow-calf operations of "live-stock share leasing" are used as an example of the costs and benefits incurred in one use of strip mined land. Experiences with dairying and with farming of hay and row crops and ceral grain crops are also discussed.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-64, p. 91-92).

7A-14-A Hill, J. K. 1965. Social and economic implications of strip mining in Harrison County. M.S. Thesis. Ohio State Univ., Columbus. 86 p.

The purpose of the study was to determine what effect strip mining has had on the people of Harrison County, Ohio. Psychological, social and cultural factors were studied and evaluated. The effects of strip mining on the community were found to include slower growth of the tax base, slower growth in business volume, and depressed agricultural land prices.

(From Dalsted and Leistritz. 1973 bibliography. No. G-11, p. 30).

7A-15 Howard, H. A. 1969. External diseconomics of bituminous coal surface mining. A case study of eastern Kentucky, 1960-1967. Ph.D. Diss. Indiana Univ., Bloomington. Also in Diss. Abstr. 30(5):1720. Also in Nat. Resources J. 11(1):76-101.

7A-16-A McLaren, D. 1973. Impact of coal mining on the Greater Wabash Region. Greater Wabash Regional Planning Commission, Grayville, Ill. 23 p.

The report evaluates the coal mining potential for the counties of White, Edwards, Wabash and Wayne in Illinois. The estimated socioeconomic impact of the Wabash Mine is provided in terms of regional needs to accommodate an estimated 600 miners.

(From Dalsted and Leistritz. 1973 bibliogrphy. No. G-18, p. 31-32).

7A-17 Mountain Plains Federal Regional Council. 1975. Socioeconomic impacts and federal assistance in energy development impacted communities in Federal Region VIII. Mountain Plains Fed. Regional Council, Denver, Colo.

7A-18-A Murphy, M. J. 1975. Using the Fort Union coal to meet national energy demands: A test of our social and economic values and systems, p. 371-381. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 4. Eastern Montana Coll., Billings.

An overview of the current energy situation of the U.S. is presented. The taconite industry is suggested as a possible alternative source for synthetic gas prior to 1985. Possible solutions are given to the inherent problems of mining Fort Union coal, based on 11 basic assumptions.
(From author's abstract).

7A-19 Riley, C. V. 1947. An ecological and economic study of coal stripped lands in eastern Ohio. M.S. Thesis. Ohio State Univ., Columbus.

7A-20 Risser, H. E. 1958. The economics of the coal industry. School of Business, Bureau of Business Research, Univ. Kansas, Lawrence.

7A-21 Stanford Research Institute. 1975. A western regional energy development study: Economics. Stanford Res. Inst., Menlo Park, Calif. (Discussion draft).

7A-22* Turner, W. R. 1958. The effects of acid mine drainage on the fish population of Goose Creek, Clay County, Kentucky. (See 3C-76-A).

B. Sociological Impacts of Strip Mining

7B-1-A Bickel, D., and C. Markell. 1975. Problems and solutions related to measuring regional attitudes toward coal development and life styles in eastern Williston Basin, p. 421-428. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol 4. Eastern Montana Coll., Billings.

High school seniors were selected as the target population for this study. The primary objectives were: (1) to gather data concerning the public attitudes toward coal development in the area and (2) to test a procedure for gathering and quantifying a large amount of attitudinal data from a sparsely populated area.

The use of high school seniors proved to be a valid technique. The results of the survey are given in detail. The regional attitudes varied, the students from southeastern Montana being much more negative in their attitudes toward coal development than those in eastern and northern portions of the state.

(Abstracted by Sally Ralston).

7B-2 Bucklaw, W. H. 1960. Effect of stripmining on public schools. M.A. Thesis. Ohio State Univ., Columbus.

7B-3 Burch, W. R. 1971. Daydreams and nightmares: A sociological essay on the American environment. Harper and Row, New York.

7B-4-A Chaplin, R. L. 1961. Spatial changes in coal development within southern Illinois--1900-1960. M.S. Thesis. Southern Illinois Univ., Carbondale. 80 p.

The purpose of this study was to analyze the spatial change in coal employment in southern Illinois during the period 1900-1960. Coal mining employment was found to have declined since 1920 based on declining demand and mine mechanization. Total coal production was expected to increase in the future with major emphasis placed on strip mining.

(From Dalsted and Leistritz. 1973 bibliography. No. G-6, p. 30).

7B-5 Copeland, O. L., and P. E. Parker. 1972. Land use aspects of the energy crisis and western mining. J. For. 70(11): 671-675.

7B-6-A Doerr, A. H. 1962. Coal mining and changing land patterns in Oklahoma. Land Econ. 38:51-56.

This report discusses how coal mining in Oklahoma has yielded dramatic changes in pre-existing land patterns.

(From Dalsted and Leistritz. 1973 bibliography. No. G-7, p. 30).

7B-7-A Environmental Protection Agency. 1974. Oil shale--accomplishment plan. Rocky Mountain Prairie Region, October, Environmental Protection Agency, Washington, D.C.

This accomplishment plan presents the rationale and allocation of EPA resources to carry out its responsibilities in light of major oil shale development in the Rocky Mountain states. The plan addresses primarily a regionally coordinated effort. It details the manpower and monetary requirements that Region VIII has projected as necessary to initiate a comprehensive assessment of oil shale development. The projections are based upon specific tasks described in some detail in this text. (From author's abstract).

7B-8-A Flowers, A. E. 1966. Effective reclamation sets stage for industrial development. Coal Age 71(12):66-70.

The 22 year reclamation program of Harmon Creek Coal Corp., Burgettstown, Pa., includes a modern industrial plant, swimming pool, community park, private lake, model plane airport, new high school, revegetated area, and a company nursery. (From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R66-6, p. 37).

7B-9-A French, C. L. 1975. Public land recreational use: The pattern for Johnson County, Wyoming, p. 493-503. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 4. Eastern Montana Coll., Billings.

A description of the socio-economic profile of the people using recreational areas in and around Johnson County are given. Persons from blue collar occupations proved to do the most deep camping in wilderness areas but both broad occupational categories are about equally represented in the general "packing" activities. The sex and educational background of the respondents did not show significant correlation to their usage of the available recreational areas, but age did appear to be a significant factor. The unsettling implication of this study is that the politically influential "elite" who have the strongest voice in the regional and local policies show the least use of and interest in the wilderness areas. (Abstracted by Sally Ralston).

7B-10 Gold, R. L., et al. 1974. Comparative use study of the impact of coal development on the way of life of people in the coal areas of eastern Montana and northeast Wyoming. Inst. Social Sci. Res., Univ. Montana, Missoula.

7B-11-A Guernsey, L. 1959. Land use changes caused by a quarter century of strip coal mining in Indiana. Proc. Indiana Acad. Sci. 69:200-209.

In 1959, a total of 93,836 acres had been strip mined in Indiana, an increase of 233% since 1947. Of the land which had been strip mined, 54.7% was revegetated with trees and 4.6% with grasses and legumes. Recreational uses accounted for 19.5% of the strip mined land and 26.3% was idle spoils.
(From Dalsted and Leistritz. 1973 bibliography. No. G-10, p. 30).

7B-12-A Guernsey, L. 1960. Settlement changes caused by strip mining coal in Indiana. Proc. Indiana Acad. Sci. 70:158-164.

This report concerns the effects strip mining has on settlements, urban and rural, roads and farms in Indiana.
(From Dalsted and Leistritz. 1973 bibliography. No. G-9, p. 30).

7B-13-A Hutchinson, P. 1975. So you think you want to mine on Indian lands, p. 18-24. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 1. Eastern Montana Coll., Billings.

A description of the social and political problems encountered during the development and operation of a surface coal mine in Montana. The area to be mined lies on Indian owned lands. The political and managerial problems to be dealt with during the development on Indian-owned lands are detailed in this paper.
(Abstracted by Sally Ralston).

7B-14 Institute for Research of Human Resources. 1973. The demand and supply of manpower in the bituminous coal industry for the years 1985 and 2000. Pennsylvania State Univ., University Park. (Available from NTIS).

7B-15-A Jobes, P. C. 1975. The right to participate: Attitudes regarding land use and development in southeastern Montana, p. 410-420. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 4. Eastern Montana Coll., Billings.

Input from the inhabitants of the Decker-Birney study area is examined to describe and illustrate one set of problems associated with the implementation of NEPA and MEPA legislation concerning coal development.

The author wishes to emphasize that social impacts involve more than socioeconomic and socio-demographic alterations upon the indigenous population. Alterations in the way of life and interaction systems may constitute the most profound impacts upon the social environment.

Public opinion input is examined in terms of occupation, where the respondent currently resides, and the number of years lived in the area. The author maintains that the positions taken on coal development by the local populace are of critical importance.

(Abstracted by Sally Ralston).

7B-16 Joseph, H. 1973. Socio-economic patterns of outdoor use near urban areas. J. Leisure Res. 4(3):218-219.

7B-17-A Leholm, A. G., and F. L. Leistritz. 1975. Profile of North Dakota's coal mine and electric power plant operation work force, p. 467-479. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 4. Eastern Montana Coll., Billings.

The study was designed (1) to determine the types of employment in North Dakota coal mines and power plants (2) to identify the socioeconomic characteristics of the existing coal industry work force and (3) to determine employee tenure, commuting patterns and original location.

Results indicate that the existing coal industry does not require highly formally educated workers: 72% of the current work force had 12 years or less of formal schooling. Many of the employees received on-the-job training and a considerable degree of internal promotion is evident for the highly skilled jobs. It is quite likely that a rural labor force would make good recruits for coal industry expansion. Employees with high levels of education tend to: (a) have shorter job tenure and (b) comprise a major part of the immigrant labor force.

(Abstracted by Sally Ralston).

7B-18-A Leistritz, F. L., and T. A. Hertsgaard. 1973. Coal development in North Dakota: Effect on agriculture and rural communities. North Dakota Farm Res. 31(1):3-9.

The objective of the report is to determine the effect of coal development on agriculture and rural communities. The impact of coal development is discussed with reference to an eight county area in southwestern North Dakota designated as State Planning Region 8. The impact on agriculture will come in three areas: competition for land, competition for water, and competition for labor. The impact on rural communities is discussed with respect to changes in employment, population and income.

(From Dalsted and Leistritz. 1973 bibliography. No. G-17, p. 31).

7B-19 Leistritz, F. L., and T. A. Hertsgaard. 1973. Effects of coal development on agriculture and rural communities in the northern Great Plains. Presented at the 1973 Annual Meeting of The American Agricultural Economics Association, August, Edmonton, Alberta, Canada. 21 p.

7B-20-A Matson, R. E. 1975. Adequacy of the coal resource data, Fort Union Region, eastern Montana, p. 67-71. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 1. Eastern Montana Coll., Billings.

The present policies and available research data on the Fort Union coal region are discussed. Present knowledge is judged inadequate in all respects.
(Abstracted by Sally Ralston).

7B-21-A McKay, M. D., and L. A. Bruckner. 1975. Status report on local impact modeling case study: San Juan County, New Mexico, p. 460-466. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 4. Eastern Montana Coll., Billings.

The presentation describes initial efforts towards the development of a linear programming model. It deals with the problems facing the Navajo Indians, who are confronted with potential coal mine and gasification industry development on their reservation.

Still in the preliminary stages, the model utilized is described as to its content, capabilties and the analysis of its output. It is primarily an economic tool, dealing with cost-profit functions. Plans to include treatments on local labor with regards to on-the-job training, expansion of industry categories and environmental aspects, however are being developed at this time.
(Abstracted by Sally Ralston).

7B-22 Miller, E. W. 1952. Penn township: An example of local governmental control of strip mining in Pennsylvania. Econ. Geogr. 28(3):256-260.

7B-23 Moore, H. R., and R. C. Headington. 1940. Agriculture and land use as affected by stripmining of coal in eastern Ohio. Dep. Rural Econ. Bull. 135. Ohio State Univ., Columbus, Ohio. (Mimeo).

7B-24-A Northern Great Plains Resource Program. 1974. Declaration of Indian rights to the natural resources in the Northern Great Plains. Native Am. Nat. Res. Develop. Fed. Northern Great Plains, Northern Great Plains Resource Program, Denver, Colo.

A declaration of the legal and constitutional rights of the Northern Great Plains Indians to the resources (including coal) in the Northern Great Plains is presented. An assessment of the overall impact coal development will have on the Indians and their environment is given.
(Abstracted by Sally Ralston).

7B-25 Pickard, C. E. 1969. The western Kentucky coal fields: The influence of coal mining on settlement patterns, forms and functions. Ph.D. Diss. Univ. Nebraska, Lincoln. 247 p. Also in Diss. Abstr. 31(1):247B.

7B-26* Pulver, J. A., and B. J. Polich. 1975. Energy development in the Rocky Mountain region: Goals and concerns. (See 6D-18-A).

7B-27-A Roseberry, J. L. 1963. Report on a survey of potential recreational utilization of Illinois strip mined land. Mid-west Coal Producers Inst., Inc., Terre Haute, Ind. 11 p.

This comprehensive treatment of reclaimed strip-mine land in Illinois emphasizes recreational use of the reclaimed land. A tabulated list by counties totals the strip acreage in Illinois and another tabulation shows ownership of the different areas. Actual acreage presently in use for recreation is listed and another table lists stripped acreage and its individual potential relating to recreational use. A number of pictures are included giving credence to the success so far of the recreational utilization. A variety of factors determine the suitability of an area for recreational use and these are enumerated. A state map shows the five strip mining districts in Illinois.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R62-10, p. 18).

7B-28-A Sitterley, J. H. 1964. Future land use in the Appalachian Plateau and its relation to strip-mine reclamation. Ohio J. Sci. 64(2):106-111.

In projecting land use in 1980 of the Ohio Segment of the Appalachian Plateau, the author predicts that "any change that is likely to occur in the relationship between land use and the reclamation of strip-mined land will arise more from the need for watershed protection, pollution control, and recreation than from a need for agriculture." The economic and sociological reasons for this conclusion are presented.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R64-31, p. 29).

7B-29-A Spang, A. T., Sr. 1975. Northern Cheyenne future, p. 35-40. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 1. Eastern Montana, Coll., Billings.

This paper is a presentation of the attitudes of the Northern Cheyenne Indians towards the plans to strip mine coal on and/or near their reservation.

With coal activity encroaching on the Northern Cheyenne, the dismay of the people can be summarized as follows: (1) Destruction of Cheyenne culture, (2) high influx of non-Indians into the reservation-Cheyenne may become a minority in their own homeland, (3) traffic or vehicular problems due to increased population, (4) pollution of all sorts, and (5) high concentrations of people brings about an increase in crime-related activities. (From author's summary).

7B-30 Stewart, E. E., and R. E. Stewart. 1974. A multiple land use study for a nine county area of southwestern North Dakota, Little Missouri Grasslands Study. North Dakota State Univ., Fargo. 300 p. with maps.

C. Policies, Laws, and Regulations

7C-1-A American Mining Congress. 1963. Surface mine land conservation. Am. Mining Congr. Annu. Convention, Pittsburgh, Pa.,

A booklet containing several papers dealing with laws, reclamation procedures and the socio-economic effects of surface mining.
(Abstracted by Sally Ralston).

7C-2 Anonymous. 1973. Coal strip mining: Energy needs vs. environment. Congr. Quarterly Weekly Rep. 31:2781-2784.

Provides an overview of the current legislative controls.
(Abstracted by Sally Ralston).

7C-3 Galpin, S. L. 1946. Discussion of regulation of strip or open cut coal operations. W. Va. Coal Mining Inst. Proc. 39:24-48.

7C-4* Gwynn, T. A. 1969. An improved environment through intelligent mined-land reclamation.
(See 6A-29-A).

7C-5-A Schmidt, R. A., and W. C. Stoneman. 1972. A study of surface coal mining in West Virginia. Stanford Res. Inst. Final Rep. to W. Va. Legislative Joint Comm. Government and Finance. Stanford Res. Inst., Menlo Park, Calif. 180 p.

Purpose of study was to provide an assessment of the results increasing control over the environmental effects of surface (contour) mining through the development of more rigorous environmental standards.
(From R. K. Honkala. 1974 bibliography. No. 513, p. 50).

7C-6-A Thirgood, J. V. 1971. The rehabilitation of the mining environment in British Columbia. Can. Mining Metallurgical Bull. 64(712):90-95. (Available from Faculty of Forestry, University of British Columbia, Vancouver, Canada).

A review of legislation on and reclamation of coal mining spoil in British Columbia and 3 years research in the Faculty of Forestry, University of British Columbia.
(From British bibliography, unpubl., p. 54).

VIII. TECHNIQUES AND METHODS OF RECLAMATION

A. Climate and Topography

8A-1* Barkley, D. G., et al. 1965. Effects of mulches on microclimate and turf etablishment.
(See 1A-2).

8A-2 Bishop, A. W. 1955. The use of slip circle in stability analysis of earth slopes. Geotechnique 5:7-17.

8A-3* Coates, W. E. 1973. Landscape architectural approach to surface mining reclamation.
(See 1B-3-A).

8A-4* Curtis, W. R. 1971. Terraces reduce runoff and erosion on surface-mine benches.
(See 1B-5-A).

8A-5-A Durfee, R. C., et al. 1975. Assignment of ERTS and topographical data to geodetic grids for environmental analysis of contour strip mining. Oak Ridge National Lab., Tenn. 55 p. (NTIS No. CONF-751074-1).

Computer techniques are presented for converting ERTS classified landcover patterns, Defense Mapping Agency topographic data, and geographical variables from other sources onto a common geodetic grid composed of latitude-longitude cells. Spatial analysis techniques are then used to assess the environmental and aesthetic impact of coal surface mining in the New River basin of east Tennessee.
(From NTIS).

8A-6-A Environmental Protection Agency. 1975. An application of ERTS technology to the evaluation of coal strip mining and reclamation in the Northern Great Plains. National Field Investigations Center, Denver, Colo. EPA, Region VIII, Denver, Colo. (NTIS No. EPA/330/3-75/001).

A study was conducted of the coal mines in Wyoming, Montana, North and South Dakota using remote sensing data from Earth Resources Technology Satellite (ERTS). The study documented the size, shape and location of the actively mined area, untouched spoils piles, reclaimed or recontoured areas, newly vegetated areas and abandoned spoils piles within each of the 30 active, inactive or proposed coal mine sites. Land use, or classification, at each mine evaluated was defined by computer processing of ERTS data from digital magnetic tapes. In most cases the computer classification techniques were successful in delineating mine areas, particularly large areas, into active mining and revegetated spoils areas, and graded and ungraded spoils piles.
(From NTIS).

8A-7-A Hill, R. D. 1971. Restoration of a terrestrial environment--the surface mine. Presented at Assoc. Southern Biol., Richmond, Va. 22 p.

A description of damages caused by surface mining with emphasis on coal mines. Mining techniques which cause minimum damage and restoration procedures are given. It is concerned mainly with the regrading of the surface when strip mining is finished. Details of contour pasture and swallowtail back filling.

(From British biblography, unpubl., p. 41).

8A-8 Hoffman, G. J., G. O. Schwab, and R. B. Curry. 1964. Slope stabilization of coal strip mine spoil banks. Ohio Agric. Exp. Sta., Wooster Eng. Dep. Ser. No. 8. Wooster, Ohio. 18 p.

8A-9* Limstrom, G. A. 1967. How stripland grading affects survival and growth.

(See 1B-15).

8A-10 McIntyre, D. B. 1963. Program for computation of trend surfaces and residuals of degree 1-8. Seaver Lab., Dep. Geol., Pomona Coll., Claremont, Calif.

8A-11-A New Mexico State Highway Department. 1970. Progress for stabilization of Federal aid highways in New Mexico, 1965-1970. Project Report, New Mexico State Highway Dep., Albuquerque.

Stabilization seedings were made to reduce soil erosion on rights-of-ways and to protect adjacent lands from siltation and pollution. Long fibre mulches, applied with asphalt, were most effective in stabilizing soil, reducing erosion and encouraging grass growth and survival on critical areas. Low cost methods, such as broadcast seeding with little or no bed preparation, were generally not successful. Competition by desirable species appeared to be the most effective and cheapest weed control. Natural revegetation of New Mexico roadsides normally takes 3 to 5 years on relatively stable areas with seed source from adjoining rangelands. During the 5-year period the State Highway Department had 19 stabilization seeding contracts. All were successful; results and costs are detailed.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage).

8A-12* Roberts, J. R. 1971. Grading and slopes used in reclamation.

(See 1B-20).

8A-13* Yamamoto, T. 1975. Trend surface analysis of Powder River Basin, Wyoming-Montana.
(See 3E-55-A).

B. Soils and Spoils

8B-1* Adams, L. M., et al. 1971. Reclamation of acidic coal mine spoil with fly ash.
(See 4A-1-A).

8B-2-A Anonymous. 1970. Factors double as stripping and reclamation units. Coal Age 75(11):112-114.

On the practicalities of controlled engineering during strip mining in anticipation of and preparation for reclamation.
(From British bibliography, unpubl., p. 32).

8B-3-A Archer, K., D. Flint, and J. Jordan. 1958. The rapid analysis of coal ash, slag and boiler deposits. Fuel 37(4):421-443.

A detailed description is given of the methods now used by the British Coal Utilization Research Association for the rapid, complete analysis of inorganic residues from coal. These methods are of general applicability to the analyses of coal ash clinker, slag, boiler dusts and deposits. Colorimetric procedures, "Unicam SP600; spectrophotometer EDTA and "Eel" flame photometer are used in determination of silicon, aluminum, iron, titanium, manganese, phosphorus, calcium, magnesium, sodium, and potassium. Sulphur is determined gravimetrically.
(From British bibliography, unpubl., p. 105).

8B-4* Ashby, W. C., and M. B. Baker. 1968. Soil nutrients and tree growth under black locust and shortleaf pine in strip-mining plantings.
(See 4A-7-A).

8B-5* Barkley, D. G., et al. 1965. Effects of mulches on microclimate and turf establishment.
(See 1A-2).

8B-6-A Berg, W. A. 1969. Determining pH of strip-mine spoils. U.S. Forest Serv. Res. Note NE-98. Northeast. For. Exp. Sta. 7 p.

Comparion of several methods of determining pH of spoils shows that the LaMotte-Morgan method and a modification of it gave the least deviation from values determined by a pH meter. Suggestions are made for adequate sampling of spoils.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R69-2, p. 47).

8B-7 Bradshaw, A. D., A. H. Fitter, and J. F. Handley. 1973. Why use topsoil in land reclamation? Surveyor 141(4224): 39-41.

8B-8-A Bremner, J. M. 1965. Methods of soil analysis. *In* C. A. Black (ed.). Am. Soc. Agron., Madison, Wisc.

Chapter 83. Total nitrogen-kjeldahl method with all necessary modifications like leaving to stand in water, to allow expansion of clay lattices, etc. Determination of nitrate and nitrite.

Chapter 84. Methods of analysis of inorganic forms of N in soils and rocks.

(Abstracted by Sally Ralston).

8B-9-A Bridges, E. M. 1966. Soils of the disturbed areas, p. 99-103. *In* The soil and land use of the district north of Derby. Mem. Soil Surv. Great Britain. Harpenden (Herts.) Rothamsted Exp. Sta., Agric. Res. Council, England and Wales.

Conditions for working opencast coal: Topsoil must be removed to a maximum depth of 12 inches before extraction operations begins. On replacement topsoil must cover a 3-foot boulder and bind free layer which has been scarified to prevent pan formation and help drainage. The appearance of the reclaimed site must be in keeping with that of the surrounding land. Descriptions of seeding mixtures and fertilizers found most successful are given.

(From British bibliography, unpubl.).

8B-10-A Brinkman, G. 1963. Land reclamation. Mining Equipment News 15(11):10.

Describes the soil reclamation efforts of strip mine operations.

(Abstracted by Sally Ralston).

8B-11* Chapman, A. G. 1967. Effects of spoil grading on tree growth. (See 2A-16-A).

8B-12* Childs, E. C., and E. G. Young. 1959. The use of moisture characteristics curves in assessing the soil stability of opencast coal sites.

(See 2A-17-A).

8B-13 Chipel, W. S., N. P. Woodruff, F. H. Siddoway, D. W. Fryrear, and P. J. Armbrust. 1963. Vegetative and nonvegetative mats to control wind and water erosion. Soil Sci. Soc. Am. Proc. 27:86-89.

8B-14-A Chironis, N. P. 1973. New surface-mining methods simplifying reclaiming of spoils. Coal Age 78(4):80-84.

A unique and practical approach to reclaiming surface mined land--involves the use of a 40-foot long super blade.
(Abstracted by Sally Ralston).

8B-15 Collum, R. H. J. 1971. Dust control techniques useful in surface mining and related manufacturing, p. 65-70. *In* Symposium on rehabilitation of drastically disturbed surface mined lands. Georgia Surface Mined Land Use Board, Macon, Ga., 4-5 Nov.

8B-16-A Cook, C. W., et al. 1974. Surface rehabilitation of land disturbances resulting from oil shale development. Colorado State Univ. Information Ser. No. 1, Environmental Resources Center. Colorado State Univ., Fort Collins.

A collection of papers, this booklet deals with: (1) Geomorphology, (2) the natural vegetation in the Colorado oilshale region, (3) natural and artificial rehabilitation of disturbed sites, (4) evolution of mining techniques, (5) physical and chemical characteristics of overburden spoils and soils, and (6) characteristics of spent shale which influence water quality, sedimentation and plant growth, (7) water requirements for stabilizing and vegetating spent shale in the Piceance Basin. Papers directly related to coal strip mining are listed independently.
(Abstracted by Sally Ralston).

8B-17-A Dean, K. C., R. Havens, and E. G. Valdez. 1969. Utilizaeion and stabilization of solid mineral wastes. Presented at 16th Ontario Industrial Waste Conference, Niagara Falls, Ontario. Bur. Mines, USDI, Washington, D.C.

Authors briefly reviewed possible uses for solid wastes from mines, mills and smelters. Stabilization techniques by chemical, physical, vegetative and combined methods are discussed in detail. Salient features, advantages and problems with each method are reviewed. Cost estimates for chemical stabilization are given. Vegetation studies are reviewed, including effects of salinity and heavy metals. Interaction of fertilizers with heavy metals, possible modification of structure or pH of tailings and dewatering tailings were studied. The chemical-vegetative stabilization test at McGill is reviewed.
(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

8B-18-A Despard, T. L. 1974. Avoid problem spoils through overburden analyses. U.S. Forest Serv. Gen. Tech. Rep. No. NE-10. Northeast. For. Exp. Sta., Upper Darby, Pa.

During strip mining of coal and subsequent grading operations, indiscriminant placement of toxic overburden strata at the spoil surface creates reclamation problems that are difficult and expensive to correct. Evaluation of overburden material before mining is begun is suggested as the most reliable means of predicting spoil quality and devising a reclamation plan.
(From author's abstract).

8B-19-A Dierks, H. A., W. L. Eaton, R. H. Whaite, and F. T. Moyer. 1962. Mine water control program, anthracite region of Pennsylvania, July 1955-Dec. 31. Information Circ. No. 8115. Bur. Mines, USDI, Washington, D.C. 63 p.

The author describes in detail the benefits of backfilling in the control of mine drainage pollution.
(Abstracted by Sally Ralston).

8B-20* Dobson, A. L., and H. A. Wilson. 1964. Refuse decomposition in stripmine spoils.
(See 2B-8-A).

8B-21* Doering, E. J., and W. O. Willis. 1975. Chemical reclamation for sodic strip mine spoils.
(See 2A-28).

8B-22 Foote, L. E., D. L. Kill, and A. H. Bolland. 1970. Erosion prevention and turf establishment manual. Office of Materials, Construction Div., Minnesota Dep. of Highways, St. Paul. 44 p.

8B-23* Graham, M. 1959. Erosion and the revegetation of spoil heaps: Some field trials.
(See 1B-11-A).

8B-24 Grava, J. 1960. Interpretation of soil information. Dep. Soils, Univ. Minnesota, Minneapolis.

8B-25-A Grube, W. E., Jr., and R. M. Smith. 1974. Field clues useful for characterization of coal overburden. Green Lands 4(1):24-25.

Methods for identifying different spoil types in the field are discussed and are summarized in a "Condensed Guide to Field Clues."
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R74-42, p. 122).

8B-26-A Howland, J. W. 1973. New tools and techniques for reclaiming land, p. 42-67. *In* First Research and Applied Technology Symposium on Mined-land Reclamation. Natl. Coal Assoc./ Bitum. Coal Res., Inc., Pittsburgh, Pa.

The problem of reducing the cost of earth moving was met by the development of a 40 foot, 40,000 pound angle blade. Two tractors were used in operating the big blade. Performance on both old and new spoil banks was encouraging. Design modifications necessitated by problems encountered in the field, and future testing to further improve dirt handling are discussed. Two attachments to the paper describe necessary calculations for cost evaluations: I. "Horsepower hours, a proposed guideline to evaluate bulldozer performance," and II. "Volume and work requirements (HP HRS) associated with leveling geometrically uniform parallel spoil banks (per acre basis)."

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-71, p. 93).

8B-27-A Hunter, F. 1953. Opencast coal sites reclaimed. Agriculture (London) 60:335-336.

In Northumberland, opencast coal land which has been restored and seeded has produced disappointing hay yields. Fertilizer response trials showed that nitrogen was the limiting factor. The addition of nitrogen increased the hay yield by 60-70%. Potash gave a negligible response, and phosphorus produced an increase of less than 10%.

Investigations showed that microorganisms persist in topsoil dumps and on restoration of satisfactory physical conditions the population returns to its original level. Soil insects also return as the soil structure develops.

The main problem in reclaiming opencast coal land is considered to be the poor soil structure after working. Compaction causes poor drainage and water-logging.

(From British bibliography, unpubl., p. 41).

8B-28* James, A. L. 1966. Stabilizing mine dumps with vegetation.
(See 1C-13).

8B-29* Jensen, I. B., and R. L. Hodder. 1975. Effects of surface configuration in water pollution control on semi-arid surface mined lands.
(See 1B-12-A).

8B-30* Knabe, W. 1964. Methods and results of strip-mine reclamation in Germany.
(See 2C-14-A).

8B-31-A Knabe, W. 1973. Development and application of the "DOMSDORF ameliorative treatment" on toxic spoil banks in lignite opencast mines in Germany, p. 273-294. *In* R. J. Hutnik and G. Davis (eds.) Ecology and reclamation of devastated land. Vol. 1. Gordon and Breach, New York, N.Y.

The DOMSDORF ameliorative treatment consists of the application of hydroscopic calcareous ash from nearby power plants, fertilization, and deep soil cultivation. (From author's abstract).
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-79, p. 95).

8B-32-A Krause, R. R. 1965. Equipment and extractive advances: Spoil stratification, p. 77-81. *In* Proceedings of the Coal Mine Spoil Reclamation Symposium. School Forest Resources, Coll. Agric., Pennsylvania State Univ., University Park.

The author describes planned stripping operations and techniques of reclamation needed for soil conservation. (Abstracted by Sally Ralston).

8B-33-A Krause, R. R. 1965. Preplanning of mining operations to improve reclamation, p. 71-76. *In* Proceedings of the Conference on Interaction of Urbanization and the Mineral Industries. Nat. Resources Inst., Ohio State Univ., Columbus. (Mimeo).

The author discusses planned stripping operations and reclamation techniques needed for the conservation of soil.
(Abstracted by Sally Ralston).

8B-34-A McCormack, D. E. 1974. Soil reconstruction: For the best soil after mining, p. 150-162. *In* Second Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Louisville, Ky.

In order to insure the highest use of land after mining, the author advocates planning the topmost layer of soil so that it will have, "from the surface downward to a depth of at least five feet, a sequence of horizons chosen from available soils and geologic strata that will provide the most favorable medium for plant growth." The soil and subsoil characteristics that will permit this topsoil reconstruction are described. The method is illustrated by its application to an area of south-central Powder River County, Montana.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R74-58, p. 125).

8B-35 Meyer, L. D., W. H. Wischmeier, W. H. Foster, and G. R. Foster. 1970. Mulch rates required for erosion control on steep slopes. Soil Sci. Soc. Am. Proc. 34:929-993.

8B-36-A Meyn, R. L., J. Holechek, and E. Sundberg. 1975. Short and long term fertilizer requirements for reclamation of mine spoils at Colstrip, Montana, p. 266-279. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 3. Eastern Montana Coll., Billings.

The methodology of the research described is stressed, as the results may not be applicable to other sites. The geology, soil type, climate and natural vegetation of the area are described in detail.

Varying levels of chemical fertilizer containing nitrogen, available phosphates and potassium were applied to plots of prepared mine spoils, seeded with thick spike wheatgrass (*Agropyron* sp.).

The development of an operational fertilizer program is described. The program should be applicable to all surface mined sites that require an evaluation of soil quality and fertilizer needs.

(From author's summary).

8B-37 Montana Agricultural Experiment Station. 1972. Tubelings--a new dryland technique for roadside stabilization and beautification. Montana Agric. Exp. Sta. Res. Rep. No. 18. Montana State Univ., Bozeman.

8B-38-A Moran, S. R., G. H. Groenewold, L. Hemish, and C. Anderson. 1975. Development of a pre-mining geological framework for landscape design reclamation in North Dakota, p. 308-316. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 3. Eastern Montana Coll., Billings.

The focus of the reclamation efforts in this study in North Dakota is on the development of a preliminary geochemical framework to serve as the basis for mine design. The framework consists of physically and chemically defined "reclamation units" which serve to identify materials in the soil that are deleterious or favorable for soil development and the establishment of vegetation during the reclamation periods.

First geologic data on the overburden is collected. Detailed sampling methods provide a three-dimensional picture of the overburden, forming the physical framework of the "reclamation units." Soil samples are then analyzed to determine the abundance and types of readily soluble ions. The chemical data are then integrated with the physical framework to develop the final "reclamation unit."

Landscape modelling, integrating topographic and "reclamation unit" data is then applied to the area. The resulting landscape plane must assure a minimum of surface subsidence, slope instability, erosion and contamination of surface and ground water with ions leached from the spoils.
(Abstracted by Sally Ralston).

8B-39 Neckers, J. W., and C. R. Walker. 1952. Field test for active sulphides in soil. Soil Sci. 74(6):467-470.

8B-40 Philips, G. 1966. Use of the wheel excavator: Possible application to spoil bank rehabilitation, p. 116-121. *In* J. L. Elder and N. R. Krube (eds.) Technology and use of lignite. Information Circ. No. 8304, Bur. Mines, USDI, Washington, D.C.

8B-41* Plass, W. T. 1972. Fertilization treatments increase black locust growth on extremely acid surface-mine spoils.
(See 4A-107-A).

8B-42* Power, J. F., et al. 1975. Factors restricting revegetation of strip-mine spoils.
(See 2A-62-A).

8B-43 Richards, L. A. (Ed.). 1954. Diagnosis and improvement of saline and alkali soils. U.S. Dep. Agric. Handbook 60. Washington, D.C.

8B-44-A Saperstein, L. W., and E. S. Secor. 1973. Improved reclamation potential with the block method of contour stripping, p. 1-14. *In* First Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

The block method of mining which has been used successfully in strip mining on hillsides is described in detail. Mining is carried out in sections so that overburden from an area being mined can be placed in a mined-out area as mining proceeds. Overburden handling can be planned so that acid-producing soil can be segregated and buried and topsoil can be reserved for final spreading. A cursory investigation of the economics of the block method indicates that it is no more expensive and may cost less than conventional dragline pull-back mining.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-131, p. 105).

8B-45 Seitz, W. D. 1974. Strip-mined land reclamation with sewage sludge: An economic simulation. Am. J. Agric. Econ. 56(4):799-804.

8B-46 Smoliak, S. 1965. Effects of manure, straw, and inorganic fertilizers on northern Great Plains ranges. J. Range Manage. 18(1):11-15.

8B-47-A Sopper, W. E., and L. T. Kardos. 1972. Municipal waste water aids revegetation of strip-mined spoil banks. J. For. 70(10):612-615.

Sewage effluent and liquid digested sludge were used to treat spoil from stripping Lower Kittanning bituminous coal seam in Clearfield County, Pennsylvania. Some 250 tons of the extremely acid (pH 2.0 to 3.0) spoil material were treated. In the years of the program no vegetation survived on the control plot (untreated). In all treated plots, growth was good the first year and better the second year. Since the sewage material is quite alkaline (6.8 - 7.2 pH), it is a good neutralizer and it contains many mineral constituents. Details of the treatments are given and much information is included on the various plants, trees, shrubs, and grasses which were used on the project.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R72-62, p. 76).

8B-48* Struthers, P. H., and J. P. Vimmerstedt. 1965. Rapid strip-mine reclamation.
(See 2A-75-A).

8B-49* Swanson, N. P., et al. 1967. Protecting steep fill slopes against water erosion.
(See 1C-22).

8B-50-A U.S. Atomic Energy Commission. 1963. Erosion control uranium mill tailings project, Monticello, Utah. RMP-3005. U.S. Atomic Energy Comm., Washington, D.C.

This project involved stabilization and revegetation of 40 acres of mill tailings at Monticello, Utah. Average annual precipitation is quoted at 14 inches. Tailings were graded, covered with rock, sand and topsoil. Both commerical fertilizer and manure were added and grasses seeded with rangeland drill. Some watering was done to germinate the spring seeding. Costs were quoted at $190,000. Report lists seeding, soil analyses as to pH, radiation readings, fertilizer applied, material moved, equipment used and evaluation of reports.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

8B-51-A U.S. Forest Service. 1971. Surface mine rehabilitation: Report of cooperative administrative study to rehabilitate phosphate strip mine sites. Caribou National Forest, Pocatello, Idaho. U.S. Forest Service, Washington, D.C.

A report on the investigation of (1) mechanical treatments necessary to retain moisture on site and minimize runoff, (2) vegetation capable of becoming established on mine spoil, (3) micro-environment conditions limiting plant establishment, and (4) chemical and physical treatments necessary to establish vegetation.

Experiments and results are profusely illustrated with color photographs. Appendix includes suggested species planting list.

(From British bibliography, unpubl., p. 57).

8B-52-A VanLandingham, A. H. 1965. Mined area restoration today. J. Soil Water Conserv. 20(4):185-186.

Mining methods, rehabilitation after mining, research on strip mine spoil, use of reclaimed areas, and factors affecting reclamation are discussed. The Soil Conservation Service develops a revegetation plan for each permit submitted after the grading is completed. The most striking difficulty in dealing with spoil areas is the extreme variation in physical and chemical characteristics which exist on such areas. These characteristics differ from area to area, bank to bank and from spot to spot in the same bank.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R65-24, p. 35).

8B-53 Voelker, S. W. 1973. Need for research on land policy issues associated with strip mining. (Soil reclamation). Great Plains Agric. Council Publ. 64:112-121.

8B-54-A Weigle, W. K., and G. P. Williams, Jr. 1968. Match additive to soil type for best stabilization. Rural and Urban Roads 1968(June):2 p.

Laboratory tests were made on eight additives to find their effectiveness in stabilizing roads used by coal operators. The additives were NaCl, $CaCl_2$, lime, tar (RT-2), emulsified asphalt (MC-3), asphalt (SS 1h), sealing oil (AE-100) and mixing oil (AE-200). Of these asphalt, sealing oil and mixing oil gave the most satisfactory results and are to be tested in the field.

(From British bibliography, unpubl.).

8B-55-A Werner, W. 1968. Effect of overhead irrigation and fertilizing on the cellulolytic activity in, and yields on, a spoil bank resulting from Brown Coal mining. Dtsch. Akad. Landwirtschaftwiss. Berl. Tagungsber. 98:225-231. (In German, Russian, and English).

Both overhead irrigation and complete fertilizing increased cellulose decomposition and yields of recently reclaimed soils, and the three-year trial provided evidence that rates of mineralization increased with increasing rainfall.

(From Commonw. Bur. Soil. Annot. Bibliogr. 1456. No. 37).

8B-56 Wildung, R. E., and J. J. C. Hsieh. 1969. Bentonite stabilization of soil to resist wind erosion. Soil Sci. Soc. Am. Proc. 33:637-638.

8B-57* Williams, G. P., Jr. 1973. Changed spoil dump shape increases stability on contour strip mines.

(See 1B-25-A).

8B-58 Wischmeier, W. H., C. B. Johnson, and B. V. Cross. 1971. A soil erodibility nomograph for farmland and construction sites. J. Soil Water Conserv. 26(5):189-193.

8B-59-A Young, C. A. 1969. The use of vegetation to stabilize mine tailings areas at Copper Cliff. Can. Mining J. 90(6): 43-46.

This article describes the methods International Nickel Company used to stabilize and secure vegetative cover on tailings at Copper Cliff, Ontario. Details as to preparation, seedings and fertilization are given. The tailings have a pH of 4.0. Grass has been established on over 500 acres.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

C. Aquatic

8C-1* Bovee, K. 1975. Assessment and implementation of "in-stream value studies" for the Northern Great Plains. (See 3E-5-A).

8C-2 Corey, A. T., and W. D. Kemper. 1968. Conservation of soil water by gravel mulches. Hydrology Pap. No. 30. Colorado State Univ., Fort Collins. 3 p.

8C-3 Dambach, C. A., and J. H. Olive. 1969. Development of biological indices to pollution levels in streams affected by acid mine drainage and oil field brine wastes. Water Resources Center, Res. Compl. Rep., Project A-003-OHIO. Ohio State Univ., Columbus. 90 p.

8C-4-A Dills, G., and D. T. Rogers, Jr. 1974. Macroinvertebrate community structure as an indicator of acid mine pollution. Environ. Pollut. 6:239-262.

Physiochemical parameters and benthic macroinvertebrate community structure were quantitatively related to varying degrees of acid mine drainage in a small stream system. Tributaries exposed to acid effluents were characterized by a reduction in turbidity, a decrease in pH, an increase in mineral content. Strong positive correlation existed between hardness, iron, manganese, pH, conductivity and sulfur. Hydrogen ion concentration was highly correlated to species diversity of the macroinvertebrate community. Significant differences in species diversity existed between strongly acidic and less acidic tributaries. Stations located near areas of acid production were consistently lowest in diversity. Species diversity values for the unpolluted stations showed temporal variations with the highest values occurring during late March and December. The more acidic stations showed no seasonal trends in diversity values. Varying degrees of acid mine pollution were reflected by changes in the macroinvertebrate community structure. (Abstracted by Sally Ralston).

8C-5 Environmental Protection Agency. 1971. Control of mine drainage from coal mine mineral wastes. Truax-Traer Coal Co. for the EPA, Project No. 14010, DDK, 08/71. EPA, Washington, D.C.

8C-6 Environmental Protection Agency. 1972. Guidelines for erosion and sediment control planning and implementation. EPA Tech. Ser. EPA-R2-72015. Proj. 15030 FW2. EPA, Washington, D.C. (Prepared by Dep. Water Resources, State of Maryland and B. C. Becker, Thomas R. Mills Hittman Assoc. Inc., Columbia, Md.)

8C-7 Erickson, A. E., C. M. Hansen, and J. M. Smucker. 1968. The influence of subsurface asphalt barriers on the water properties and productivity of sand soils. Trans. 9th Int. Congr. Soil Sci. 1:331-337.

8C-8 Ferris, O. 1973. Acid mine drainage control feasibility study. Dep. Nat. Resources and Conserv., Helena, Mont.

8C-9 Girard, L., and R. Raplan. 1967. Operation Yellowboy: Treatment of acid mine drainage. Coal Age 72(1):72-74,79.

8C-10 Goodnight, C. 1973. The use of aquatic macroinvertebrates as indicators of stream pollution. Trans. Am. Microscop. Soc. 92:1-13.

8C-11 Hammond, L. C., H. W. Lindy, and G. K. Saxena. 1967. Influence of underground asphalt barriers on water retention and movement in sakeland fine sand. Soil Crop Sci. Soc. Fla. Proc. 27:11-19.

8C-12 Hanna, G. P., Jr., et al. 1963. Acid mine drainage research potentialities. J. Water Pollut. Control Fed. 35(3):275-296.

8C-13 Hansen, C. M., and A. E. Erickson. 1969. Use of asphalt to increase water holding capacity of droughty sand soil. Ind. Eng. Chem.: Produce Res. Development 8:256-259.

8C-14 Harrell, R., J. Ashcraft, R. Howard, M. Welch, and R. Russell. 1973. Macrobenthos as indicators of ecological change. Dep. Biology, Lamar Univ., Beaumont, Texas. 58 p.

8C-15-A Kentucky, State of. 1961. Kentucky initiates research program. Mechanization 25(12):69.

Ways to reduce stream pollution in coal stripped forest water sheds.

(From R. K. Honkala. 1974 bibliography. No. 678, p. 67).

8C-16* Kimmel, W. G., and W. E. Sharpe. 1973. Acid drainage and the stream environment.

(See 3A-17-A).

8C-17 Kirk, K. G. 1972. A study of the effectiveness of back filling in controlling mine drainage, p. 331-345. *In* N. S. Barrekkette (ed.) Pollution engineering and scientific solutions: Proceedings of the 1st International Meeting of the Society of Engineering Scientists. Plenum Press, New York, N.Y.

8C-18* Larosa, P. J., et al. 1971. Overburden analysis and strip mine conditions in northeastern Ohio.
(See 2A-43-A).

8C-19-A McCarthy, R. E. 1973. Preventing sedimentation of streams in a Pacific Northwest coal surface mine, p. 277-286. *In* First Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

Water pollution control needed in developing a strip mine near Centralia, Washington was prevention of sediment in the discharge into Hanaford Creek, the receiving stream. Acid forming materials were not present. Since the claylike soil tended to remain in suspension, polyelectrolyte flocculant treatment was used in addition to settling ponds. The process was designed to handle the extended periods of high runoff and occasional peak flows common to the area. It has also been automated to continually monitor the water flow and to add the correct amount of flocculant into the turbid water. Water analysis three times a day above and below the mine, assures that the overflow from the final settling pond does not carry siltation.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-84, p. 95-96).

8C-20-A McCarthy, R. E. 1973. Surface mine siltation control. Mining Congr. J. 59(6):30-36.

The system of clarifying turbid water from the mining operation is described. Suspended sediment is flocculated with a polyelectrolyte. The suspension settles out in ponds and clear water overflows into the receiving stream.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-85, p. 96).

8C-21* Northeastern Forest Experiment Station. Freeing streams from mud and flood.
(See 3A-23-A).

8C-22* Northeastern Forest Experiment Station. Toward a quality water supply.
(See 3A-24-A).

8C-23 Packer, P. E., and F. Christensen. 1965. Guides for controlling sediment from secondary logging roads. U.S. Forest Serv. Pocket Handbook. Intermountain For. Range Exp. Sta. (Ogden, Utah) and Northern Region (Missoula, Mont.). 42 p.

8C-24* Parsons, J. W. 1951. A biological approach to the study and control of acid mine pollution.
(See 3C-55).

8C-25 Rice, P. A., and P. Rabolini. 1972. Biological treatment of acid mine water, p. 293-306. *In* C. J. Potter (ed.) 4th symposium on coal mine drainage research. Coal Industry Advisory Comm. to Ohio River Valley Sanitation Comm. Mellon Inst., Pittsburgh, Pa.

8C-26-A Richart, F. W. 1944. Handling water to save time and money at strip mines. Coal Age 49(1):59-62.

Necessary considerations of water handling in a strip mining area include a proper box cut design, drainage ditches, pumping stations, haulageways and a preparation plant. A permanent pumping system should include a frostproof or heated building. Drainage ditches should be parallel to the main pit to make diversion easier. Outdoor equipment and controls should be weatherproof and portable pumps are a requirement. Care must be practiced to make sure these pumps are drained in winter to prevent damage from freezing.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R44-1, p. 2).

8C-27 Riley, C. V. 1962. Water management in coal strip land reclamation. Kent State Univ., Kent, Ohio. 12 p.

8C-28 Sargent, T. N. 1971. Protection of streams and lakes from mining and related industrial waste, p. 59-64. *In* Symposium on rehabilitation of drastically disturbed surface mined lands. Georgia Surface Mined Land Use Board, Macon, Ga., 4-5 Nov.

8C-29 Scheaffer, K. K., and F. J. Little, Jr. 1969. Macro-invertebrates species diversity as an index to water pollution in Shamokin Creek and its tributaries. Proc. Pa. Acad. Sci. 43:73-79.

8C-30 Skinner, M. M., and R. J. Ruff. 1972. Color infrared photography and thermal infrared imagery of selected locations along the Missouri River between Omaha and Blair, Nebraska. Dep. Army, Omaha District, Corps Eng., Omaha, Nebr.

8C-31 Struthers, P. H. 1967. Prevention of water pollution by drainage from mines. Presented at 5th Meeting of Water Development Coordinating Committee for Appalachia, 15-16 Feb., Atlanta, Ga. Office of Appalachian Studies, Cincinnati, Ohio.

8C-32 Tackett, S. L., and L. F. Wieserman. 1972. Simultaneous pollarographic determination of iron (II) and iron (III) in coal mine waste water. Anal. Lett. 5(9):643-651.

8C-33* Van Voast, W. A., et al. 1975. Hydrologic impacts of coal mine effluents and spoil leachates.
(See 3B-27-A).

8C-34 Wicks, F. E. 1968. Instrumentation of strip mine study areas for hydrologic investigations. M.S. Thesis. Ohio State Univ., Columbus.

D. Plants

8D-1* Aldon, E. F., and H. W. Springfield. 1975. Techniques for establishing native plants on coal mine spoils in New Mexico.
(See 4A-4-A).

8D-2-A Anonymous 1966. P & M reclamation--Forests, lakes, recreation centers. Coal Age 71:100-107.

Reviews techniques used and results obtained on reclamation at Pittsburgh and Midway Coal Company mines nationwide. The Edna Mine at Oak Creek, Colorado and the McKinley at Gallup, New Mexico are in the western U.S. Revegetation at the McKinley Mine started in 1962; plantings include red cedar, ponderosa pine and fescue grass. At the Edna, native trees, scrub trees, Russian olive and various grasses have been planted.
(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

8D-3-A Armstrong, W. H. 1968. Establish drought-tolerant plants by direct seeding. California Div. Highways, Dep. Public Works, Sacramento.

This is a review of the progress of research at the University of California (Davis) toward establishing drought-tolerant plants by direct seeding methods. Plant species are being evaluated for drought-tolerance, aggressiveness, insect and disease resistance and appearance. Seeding methods are being designed to make optimum use of natural conditions. Soil temperatures, moisture readings and plant survival are tabulated.
(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

8D-4 Barry, W. J., and R. N. Sach. 1968. Vegetative propagation of quaking aspen. California Agric. 22(1):14.

8D-5* Beauchamp, H., et al. 1975. Topsoil as seed source for reseeding stripmine spoils.
(See 2A-4).

8D-6 Bement, R. E., R. D. Barmington, A. C. Everson, L. O. Hylton, Jr., and E. E. Remmenga. 1965. Seeding of abandoned croplands in the Central Great Plains. J. Range Manage. 18:53-58.

8D-7-A Bement, R. E., D. F. Hervey, A. C. Everson, and L. O. Hylton, Jr. 1961. Use of asphalt-emulsion mulches to hasten grass seedling establishment. J. Range Manage. 14:102-109.

The effect of two asphalt-emulsion mulches on the establishment of blue grama, sideoats grama, and sudangrass was studied at the Central Plains Experimental

Range. Results were interpreted in terms of soil water, soil temperature, plant emergence, plant growth and plant survival.
(Abstracted by Sally Ralston).

8D-8 Bengtson, G. W., D. A. Mays, and T. G. Zarger. 1971. Techniques useful in establishing vegetative cover on reclaimed surface mined land. *In* Symposium on rehabilitation of drastically disturbed surface mined lands. Georgia Surface Mined Land Board, Macon, Ga., 4-5 Nov.

8D-9 Benson, M. K., and D. E. Schwalbach. 1970. Techniques for rooting aspen root sprouts. U.S. Forest Serv. Tree Planter's Notes 21(3):12-14.

8D-10 Berg, W. A. 1970. How to promote plants in mine wastes. Mining Eng. 22:67-68.

8D-11* Berg, W. A., and E. M. Barrau. 1973. Composition and production of seedings on strip-mine spoils in northwestern Colorado.
(See 4A-12-A).

8D-12 Blazer, R. E. 1958. Fertilization practices and species adaptation for steep road cuts in Virginia. Agron. Abstr. 1958:64.

8D-13* Brooks, D. S., and A. F. Bates. 1960. Grasslands in the restoration of opencast coal sites in Yorkshire.
(See 4A-22-A).

8D-14 Brown, T. A. 1975. Revegetation and use of strip-mined lands. Proc. Soil Conserv. Soc. Am. 30:133-134.

8D-15 Button, E. F. 1964. Establishing slope vegetation. Public Works 1964 (Jan.).

8D-16* Coates, U. A. 1960. Experiment in grassland establishment on colliery shale, Brickershaw Reservoir site, Abram. 1954-1960.
(See 4A-28-A).

8D-17 Cook, C. W. 1970. Seeding methods for Utah road sites. Utah Resource Ser. 52. Utah Agric. Exp. Sta., Utah State Univ., Logan. 23 p.

8D-18-A Cook, C. W., R. M. Hyde, and P. L. Sims. 1974. Guidelines for revegetation and stabilization of surface mined areas in the western United States. Range Sci. Dep. Sci. Ser. No. 16. Colorado State Univ., Fort Collins. 70 p.

This paper presents guidelines for techniques of: (1) seeding, (2) top-soiling, (3) fertilizers, (4) mulches, (5) weed control, (6) management during establishment,

(7) preliminary planning and lease agreements, and (8) reclamation of native vegetational types.

Also included are specific guidelines for: The Northern Great Plains, desert vegetation types, foothill vegetation types, intermediate types and high elevation types.

It is emphasized that more work is needed in all areas.

(Abstracted by Sally Ralston).

8D-19-A Czapowskij, M. M., and R. Writer. 1970. Hydroseeding on anthracite coal mine spoil. U.S. Forest Serv. Res. Note NE-124. Northeast. For. Exp. Sta., Upper Darby, Pa.

A study was made of the performance of selected species of legumes, grasses and trees hydroseeded on anthracite coal mine spoils in a slurry of lime, fertilizers and mulch. Hydroseeding failed on coal-breaker refuse, but was partially successful on strip-mine spoils.

(From author's abstract).

8D-20-A Dale, M. E. 1963. Interplant alder to increase growth in strip-mine plantations. U.S. Forest Serv. Res. Note CS-14. Central States For. Exp. Sta., Columbus, Ohio. 4 p.

Results from a 5 year old planting indicate that European alder is beneficial as a nurse crop to other tree species on a strip mined area in eastern Kentucky. The nursing effect of alder did seem to stimulate height growth of 10 species, some more than others.

(From text).

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R63-2, p. 19).

8D-21-A Davidson, W. H., and E. A. Sowa. 1973. Container-grown seedlings shows potential for afforestation of Pennsylvania coal mine spoils. U.S. Forest Serv. Tree Planter's Notes 25(4):6-9.

Red pine seeds were planted in a variety of types of planters--peat, asphalt tube, Ontario plastic tube, etc. The young trees were then transplanted at various ages into three spoil types considered most difficult. To vegetate: (1) anthracite coal breaker refuse, (2) bituminous strip mine spoil and (3) bituminous breaker refuse. A detailed discussion of the data is given. Larger containers showed more potential for establishing vegetation on coal-mine spoils than the smaller ones.

(Abstracted by Sally Ralston).

8D-22 Dudek, A. E. 1969. Establishment and use of turf and other ground covers, p. 1-68. *In* 1968 Annual Report: Highway Research Project I. Univ. Nebraska and Nebraska Dep. Roads, Lincoln.

8D-23 Evans, R. A., J. A. Young, and R. E. Eckert. 1969. Herbaceous weed control and revegetation of semiarid rangelands in the western U.S. Outlook Agric. 6:60-66.

8D-24 Farmer, R. E., Jr. 1963. Vegetative propagation of aspen by greenwood cuttings. J. For. 61(5):385.

8D-25-A Gibbons, J. 1961. Experiments on restored opencast coal sites--Cultivation experiments. Exp. Husb. 6:105-108.

It is concluded from results at two sites that while rotovating can, in some circumstances, give a suitable tilth when required, the traditional plowing has much in its favor. There are indications that subsoiling is beneficial, though its ultimate effect on yield, particularly of winter wheat, is not marked.
(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 47).

8D-26-A Grabe, D. F. 1957. Artificial drying and storage of smooth bromegrass seed. Agron. J. 49:161-165.

Methods for the correct drying of moist bromegrass seed are discussed.
(Abstracted by Sally Ralston).

8D-27-A Green, N. E., and R. M. Hansen. 1969. Relationship of seed weight to germination of six grasses. J. Range Manage. 22(2):133-134.

Percentage of germination was greater for heavy seeds than lighter ones. Rate of germination was also greater for the heavy seeds. Sand bluestem, sideoats grama, blue grama, switchgrass, and yellow infragrass were the species studied.
(Abstracted by Sally Ralston).

8D-28 Hodder, R. L. 1970. Revegetation methods and criteria for bare areas following highway construction. Anim. Range Sci. Dep., Montana State Univ., Bozeman. 97 p.

8D-29 Hodder, R. L. 1970. Roadside dryland planting research in Montana. Highway Res. Record 335:29-34.

8D-30 Hodder, R. L., B. W. Sindelar, and M. E. Majerus. 1973. Revegetation research on surface mined land--A script for a series of slides. Montana Agric. Exp. Sta. Misc. Publ. 13, Bozeman. 15 p.

8D-31 Hovland, D., D. E. Wesley, and J. Thomas. 1966. Establishing vegetative cover to protect roadside soils in South Dakota. South Dakota Agric. Exp. Sta. Bull. 527. South Dakota State Univ., Brookings. 31 p.

8D-32 Hull, A. C., Jr. 1971. Grass mixtures for seeding sagebrush lands. J. Range Manage. 24(2):150-152.

8D-33 Hull, A. C., Jr., D. F. Harvey, C. W. Doran, and W. J. McGinnies. 1958. Seeding Colorado rangelands. Colorado Agric. Exp. Sta. Bull. No. 498-5. 46 p.

8D-34* Jones, R. G. 1966. Revegetation of mine spoil tips in South Wales coalfield.
(See 4A-77-A).

8D-35 Kay, B. L. 1976. Hydroseeding, straw, and chemicals for erosion control. Agron. Prog. Rep. No. 77. Univ. California, Davis. 14 p.

8D-36-A Kittock, D. L., and J. K. Patterson. 1962. Seed size effects on performance of dryland grasses. Agron. J. 47:472-477.

Larger seeds were shown to produce more vigorous seedlings.
(Abstracted by Sally Ralston).

8D-37-A Knabe, W. 1964. A visiting scientist: Observations and recommendations concerning strip-mine reclamation in Ohio. Ohio J. Sci. 64:132-157.

A general review article discussing problems of forest revegetation.
(Abstracted by Sally Ralston).

8D-38 Knipe, O. D. 1967. Influence of temperature on the germination of some range grasses. J. Range Manage. 29(5):298-299.

8D-39-A Knipe, O. D. 1971. Light delays germination of alkali sacaton. J. Range Manage. 24(2):152-154.

Exposure of alkali sacaton seeds to light for a few seconds after imbibition delayed germination 24 hr; exposure for 9 to 13 hr delayed germination 28 hr; exposure for more than 13 hr delayed germination 72 hr, and continuous exposure reduced germination 40%.
(Abstracted by Sally Ralston).

8D-40 Lang, R. L., F. Rauzi, W. Semands, and G. Howard. 1975. Guidelines for seeding range, pasture and disturbed lands. Wyoming Agric. Exp. Sta. Bull. No. 621. Univ. Wyoming, Laramie.

8D-41-A Launchbaugh, J. L., and C. E. Owenby. 1970. Seeding rate of first-year stand relationships for six native grasses. J. Range Manage. 23(6):414-417.

Average percent establishment in relation to seeding rates of 4, 12, 36, and 108 seeds/foot of row, was found to be 9.3, 5.3, 3.7, and 2.6 in the same order. (Abstracted by Sally Ralston).

8D-42-A Lavai, F. J., and J. D. Robins. 1972. Revegetation augmentation by reuse of treated active surface mine drainage. EPA Environ. Protection Technol. Serv. EPA-R2-72-119. EPA, Washington, D.C. 147 p.

Two active surface mine sites in Kentucky were evaluated to determine the feasibility of conducting a full-scale demonstration project on the use of neutralized acid mine drainage to irrigate new vegetative cover or regraded spoil banks. The site in the western coal field was chosen on the basis of water analyses and the nutrient requirements of the spoil banks. Water collection, neutralization plant and irrigation techniques were evaluated to determine the most feasible methods. Cost estimates are given.
(Adapted from authors' abstract).
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R72-30, p. 69-70).

8D-43* Limstrom, G. A. 1952. Effects of grading strip mined lands on the early survival and growth of planted trees. (See 1B-14).

8D-44 McCully, W. G., and W. J. Bowmer. 1966. Promotion and establishment of vegetation for erosion control. Texas Transportation Res. 2:2-18,63-67. (Texas Transport Inst., Texas A&M Univ., College Station).

8D-45* McGinnies, W. J., et al. 1963. A summary of range grass seeding trials in Colorado. (See 4E-53).

8D-46* Meyn, R. L., et al. 1975. Short and long term fertilizer requirements for reclamation of mine spoils at Colstrip, Montana. (See 8B-36-A).

8D-47 Moldenhauer, W. C., J. Maddy, B. L. Schmidt, and W. D. Shrader. 1964. Establishing vegetation on exposed subsoil in southern Iowa and northern Missouri. USDA Information Bull. 280. U.S. Dep. Agric., Washington, D.C. p. 115.

8D-48 Nelson, J. R., A. M. Wilson, and C. J. Goebel. 1970. Factors affecting broadcast seeding in bunchgrass range. J. Range Manage. 23:163-170.

8D-49 Newhard, E. E. 1957. Establishment of a cover turf on a mixture of stone and quarry dust. Highway Res. Board Pub. No. 496 (Roadside Development). p. 79-80.

8D-50 Nielson, R. F., and H. B. Peterson. 1972. Treatment of mine tailings to promote vegetative stabilization. Utah Agric. Exp. Sta. Bull. 485. Utah State Univ., Logan. 22 p.

8D-51 Nikola, H. C., and S. J. Toth. 1954. Establishment and maintenance of roadside vegetation. Agron. Abstr. 46:93.

8D-52-A Nord, E. C., E. R. Schneegas, and H. Graham. 1967. Bitterbrush seed collecting--by machine or hand? J. Range Manage. 20(2):99-103.

Cost for hand stripping was $47/100 lb. and up to $424/100 lb. for machine collections.
(Abstracted by Sally Ralston).

8D-53 Power, J. F., and J. Alessi. 1971. Nitrogen fertilization of semiarid grasslands: Plant growth and soil mineral N levels. Agron. J. 63:277-280.

8D-54* Power, J. F., et al. 1975. Factors restricting revegetation of strip-mine spoils.
(See 2A-62-A).

8D-55 Repp, G. 1969. Cell physiological test method in selection of plant species for revegetation of chemically disturbed sites. Presented at International symposium on ecology and revegetation of drastically disturbed areas. Pennsylvania State Univ., University Park.

8D-56-A Rogers, A. 1971. Derelict land reclamation: Revegetation of coal and ironshale tips. Land Reclamation Office, Monmouthshire Derelict Land Reclamation Joint Committee, Monmouthshire, England. 8 p. (Typescript). (Available: c/o ICI Fibres Ltd., Ponty Pool, Monmouthshire, NP4-8YG, England).

Recommendations for the establishment of a grass cover on tips include the use of processed broiler house litter called "Chiguano" at 5 tons/acre and 35-50 lb./acre of a seed mixture. On strip slopes hydraulic seeding may be advantageous. Seven species of trees are recommended for planting on shale and exposed sites: hawthorn, white birch, rowan, sycamore, sessile oak, alder and lodge pole pine. Useful comments on the selection of planting season, age and condition of the trees and planting of them are given.
(Abstracted by Sally Ralston).

8D-57 Ruble, R. W. 1965. A review of "A guide for revegetating bituminous strip mine spoils in Pennsylvania." by the Research Commission on Coal Mine Spoil Revegetation in Pennsylvania, p. 106-110. *In* Proceedings of the Coal Mine Spoil Reclamation: Scientific planning for regional prosperity and beauty. School Forest Resources, Coll. Agric., Pennsylvania State Univ., University Park.

8D-58* Ruffner, J. D., and W. W. Steiner. 1969. Evaluation of plants for use on critical sites.
(See 4A-116-A).

8D-59 Rumbaugh, M. D., and T. Thorn. 1964. Interseeding legumes in South Dakota grasslands. South Dakota Farm Home Res. 16:7-9.

8D-60* Rumsey, W. B. 1971. Range seeding vs. climax vegetation on three sites in Idaho.
(See 4E-68).

8D-61 Savage, D. A. 1943. Methods of reestablishing buffalo grass on cultivated land in the Great Plains. U.S. Dep. Agric. Circ. No. 328. Washington, D.C. 20 p.

8D-62 Sindelar, B. W. 1973. Dryland sodding with native grasses for permanent erosion control. Montana Agric. Exp. Sta., Res. Rep. No. 43. Montana State Univ., Bozeman. 22 p.

8D-63 Slayback, R. D., and D. R. Cable. 1970. Larger pits aid reseeding of semi-desert rangeland. J. Range Manage. 23:333-335.

8D-64-A Snow, A. G. 1938. Use of indolebutyric acid to stimulate the rooting of dormant aspen cuttings. J. For. 36(6): 582-587.

Treating aspen cuttings with 10 mg of indolebutyric acid per liter of water for 27 hr results in approximately a 65% success rate. Early spring cuttings are the best.
(Abstracted by Sally Ralston).

8D-65 Soil Conservation Service. 1963. A guide for classifying and revegetating strip mine spoils in Pennsylvania. Soil Conserv. Serv., U.S. Dep. Agric., Harrisburg, Pa. 28 p.

8D-66-A Springfield, H. W. 1969. Temperature for germination of fourwing saltbush. J. Range Manage. 22(1):49-50.

Germination is greatest from 55° to 75°F. It is recommended that seeding be attempted in the cooler periods in the Southwest.
(Abstracted by Sally Ralston).

8D-67-A Striffler, W. D., and R. F. May. 1966. Forest restoration of strip mined areas. Soc. Am. For. Proc. 1965:105-108. (Available from Dep. Watershed Manage., Colorado State Univ., Fort Collins.)

A review of strip mining, their effects and restoration by afforestation.

Brief account of research programs on reclamation problems and a list of tested species.

(From British bibliography, unpubl., p. 52).

8D-68* Terwilliger, C., et al. 1974. Natural and artificial rehabilitation of disturbed sites in an oilshale area.

(See 4E-75-A).

8D-69 Troth, J. L., and J. T. May. 1974. Effects of fertilization of Kaolin strip mining spoil on spoil fertility and grass growth. Bull. Ga. Acad. Sci. 32(1-2):5-6.

8D-70-A Voysey, J. C. 1961. An assessment of the replanting of some open cast coal sites used in South Yorkshire. Quart. J. For. 55(1):24-34.

The article describes some of the techniques in replanting opencast sites used in the West Riding of Yorkshire and the results obtained. Treatment of sites before planting, the choice of species, methods of establishment and the subsequent treatment are all described.

(From author's summary).

8D-71-A Weaver, T. 1975. Area-weight relationships for common Montana shrubs, p. 703-706. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 5. Eastern Montana Coll., Billings.

A technique for predicting the biomass of shrubs by measuring their sizes is presented.

Results indicated that: (1) Weights of aboveground parts of shrubs increase non-linearly with increasing area. Equations are given to describe this relationship. (2) The large root biomass is approximately equal to the small branch biomass. (3) The leaf biomass equals approximately 0.20 to 0.25 times the small branch biomass. (4) The resulting equations have r^2 values of 0.63 to 0.88.

(Abstracted by Sally Ralston).

8D-72* Wilhelm, S., and E. Bruning. 1964. Possibilities for growing grasses and clovers as pioneer plants in revegetating tips in the region of the Linkenheerd lignite region near Frankfort.

(See 4A-133-A).

8D-73-A Wilkinson, B. 1962. Phosphate experiments on restored opencast coal soils. (1) Effect of superphosphate application to grassland. (2) Efficiency of phosphates of varying solubility on grassland. Exp. Husb. 7:105-121.

Responses to P were similar to those on undisturbed soil and varied with the states of soil P, inherent soil-P fixation and season. P is essential for establishing grass-clover sward and should be given at 4 cwt/acre super on P-deficient soils; 2 cwt/acre super should be applied annually or equivalent amounts quadrennially.

(From Commonw. Bur. Soils Annot. Bibliogr. 1027. No. 37).

8D-74* Young, C. A. 1969. The use of vegetation to stabilize mine tailings areas at Copper Cliff.

(See 8B-59-A).

8D-75-A Zarger, T. G., G. W., Bengtson, J. C. Allen, and D. A. May. 1969. Use of fertilizers to speed pine establishment on reclaimed coal mine spoil in northeastern Alabama. II. Field experiments. Presented at international symposium on ecology and revegetation of drastically disturbed areas. Pennsylvania State Univ., University Park.

Results of tests showed that the main factor limiting growth of loblolly pine (*Pinus taeda* L.) on coal mine spoil are deficiencies of N and P. A factorial trial indicated that N-P fertilizer blends of quite variable N:P ratios would yield acceptable responses, provided that at least 25 lb. of each were applied per acre. Fewer seedlings were killed by frost heaving when the spoil was fertilized. This makes seeding feasible, which has the advantage of being quicker and less expensive than hand planting of young trees.

(From British bibliography, unpubl., p. 58).

E. Animals

8E-1-A Anonymous. 1969. Canadian geese transplanted in Illinois. Coal Mining Process 6(9):33.

Canadian geese established on 30,000 reclaimed acres of a strip-mine area.
(Abstracted by Sally Ralston).

8E-2* Arata, A. A. 1959. Ecology and management of muskrats in strip-mine ponds in southern Illinois.
(See 5A-2-A).

8E-3* Birkenholz, D. E. 1958. Reclamation of a spoil area for wildlife purposes.
(See 4D-1).

8E-4 Bonsack, A. C. 1963. Wasteland or wildlife. Wisc. Conserv. Bull. 28(1):16-17.

8E-5 Bristow, J. W. 1943. Wildlife havens from stripmines. Outdoor Life 8(5):42-44. Also in Wildl. Rev. 38:38. (Abstr.)

8E-6* Burner, C. C. 1973. Fishery management in strip mine lakes.
(See 5A-6-A).

8E-7 Cole, G. F. 1956. The pronghorn antelope: Its range use, and food habits in central Montana with special reference to alfalfa. Montana Agric. Exp. Sta. Bull. No. 516. Montana State Univ., Bozeman. 63 p.

8E-8* Collins, F. W. 1957. Game management practices on strip mined lands.
(See 5A-8).

8E-9 Collins, F. W. (Year unknown). Reclaimed land and wildlife potential. Div. Strip Mine Reclamation, Kentucky Dep. Conserv., Frankfort. 22 p.

8E-10 Edminster, F. 1949. Strip mined areas can make wildlife cover. Pa. Game News 20(2):12-13.

8E-11 Emlen, J. T. 1956. A method for describing and comparing avian habitats. Ibis 98:565-576.

8E-12 Etter, H. M. 1973. Mined-land reclamation studies on Bighorn Sheep Range in Alberta, Canada. Biol. Conserv. 5(3):191-195.

8E-13 Ford, R. D. 1975. Strip mine reclamation for recreation. Proc. Soil Conserv. Soc. Am. 30:94-99.

8E-14-A Gasswint, O. 1962. Project W-20-L. Kansas Fish and Game 20(2):11-13.

Acquisition of strip pit lands for public use, chiefly pictorial description of development.
(Abstracted by Sally Ralston).

8E-15-A Gwynn, T. A. 1965. Reclaiming strip-mined land in North Dakota by establishing game management areas. Knife River Coal Mining Co., Bismarck, N.D. 36 p.

The author gives a review of strip mine problems and reclamation in North Dakota. The Knife River Coal Mining Company research on reclamation of its properties in North Dakota and Montana dates from 1963. Soil analyses and fertility tests of the soils were made. Wildlife habitat was selected as the optimum use of the mined lands. A wide variety of grasses, shrubs and trees were tested in diverse sites--20,000 seedlings planted in 1964. Information is given on tree survival by site and species, recommended hand planting methods for trees, and effect of spoil bank grading.
(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

8E-16* Gwynn, T. A. 1966. Reclaiming strip-mined land by establishing game management areas--A progress report.
(See 4D-5-A).

8E-17-A Gwynn, T. A. 1967. Reclaiming strip-mined land by establishing game management areas. Index '67, 27 Aug.-2 Sept., Regina, Saskatchewan, Canada. 14 p.

Discussion of the reclamation of lignite mining areas in North Dakota.
(Abstracted by Sally Ralston).

8E-18 Harper, H. 1961. Tree and shrub plantings for wildlife habitat improvement. Idaho Wildl. Rev. 13(5):6-9.

8E-19-A Kays, C. E. 1967. Wildlife, recreation, p. 71-75. *In* Strip mining symposium, Owensboro, Ky. Dep. Nat. Res., Div. Reclamation, Frankfort, Ky.

The paper describes the potentials of strip mined lands for development as fish and wildlife habitats.
(Abstracted by Sally Ralston).

8E-20-A Klimstra, W. D. 1959. The potential of wildlife management on strip-mined area. Ill. Wildl. 14(2):5-9.

The roles of vegetation and of water in the occurrence of wildlife on strip-mined land are discussed.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R59-5, p. 12).

8E-21-A Klimstra, W. D., P. A. Vohs, Jr., and J. W. Cherry. 1963. Strip-mined lands for recreation. Ill. Wildl. 18(4):6-8.

The Pyatt's Research area was formerly strip mined by Truax-Traer Coal Co. The development and use of these lands for recreation is described.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R63-8, p. 20).

8E-22 Ohio State University. 1968. Potentials of strip mined area for fish and wildlife habitat. Res. Foundation, Ohio State Univ., Columbus. 84 p.

8E-23 Passey, H. B., and V. M. Hicks. 1970. Grassland restoration and its effects on wildlife. U.S. Dep. Agric., Soil Conserv. Serv., Washington, D.C.

8E-24* Plummer, A. P., et al. 1968. Restoring big game range in Utah.
(See 6C-82).

8E-25* Riley, C. V. 1952. An evaluation of reclaimed coal strip mined lands as wildlife habitats.
(See 4D-8).

8E-26* Riley, C. V. 1953. Striplands can produce wildlife.
(See 4D-9).

8E-27* Riley, C. V. 1954. The utilization of reclaimed coal striplands for the production of wildlife.
(See 4D-10-A).

8E-28* Riley, C. V. 1957. Reclamation of coal strip mined lands with reference to wildlife plantings.
(See 4D-11-A).

8E-29* Riley, C. V. 1963. Revegetation and management of critical sites for wildlife.
(See 4D-12-A).

8E-30* Roseberry, J. L., and W. D. Klimstra. 1964. Recreational activities on Illinois strip-mined lands.
(See 6B-20-A).

8E-31* Smith, H. G. 1964. Spoil banks and bird life.
(See 5A-28).

8E-32-A Verts, B. J. 1956. A place to hunt. Ill. Wildl. 12(1).

Wildlife development on 924 acres donated by Truax-Traer Coal Co. to southern Illinois University is described. An animal survey was made and the area was opened to the public for hunting and fishing. Surveys of hunters showed that revegetated strip mine lands can be developed as good public hunting areas.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R56-5, p. 9).

8E-33-A Vohs, P., Jr., and D. E. Birkenholz. 1962. Response of bobwhite quail to management on some Illinois strip-mined lands. Ill. Acad. Sci. Trans. 55(1):13-19.

Responses of bobwhite quail to management practices applied on 920 acres of strip-mined land in southern Illinois have been studied since 1954. Practices employed included road construction, grading of spoils and widening of spoil valleys, manipulation of cover and introducing plant species which produce food for quail. An increase of bobwhites from 46 prior to incorporation of management to 279 in 1959-60 was recorded. An analysis of the crops of 49 quail obtained in 1959-60 indicated a dependence of the birds on plant species introduced through management.
(From author's summary).
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R62-12, p. 19).

8E-34 Wali, M. K. (Ed.). 1975. Introduction: the problem of land reclamation viewed in a systems context, p. 1-17. *In* Symposium on practices and problems of land reclamation in western North America. Univ. North Dakota Press, Grand Forks.

8E-35 Yeager, L. E. 1940. Wildlife management on coal stripped land. N. Am. Wildl. Conf. Trans. 5:348-353.

F. Humans

8F-1-A Gold, R. L. 1975. On generating usable social science research data, p. 504-508. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 4. Eastern Montana Coll., Billings.

Twenty-four observations and recommendations on the efficacy of current techniques employed in the social sciences are given. Some of these are: (1) Most social scientists are trained in pure, not applied science, (2) The language used in reports is generally incomprehensible to people outside the field, (3) Social scientists evidently know very little about what constitutes useful information for non-academics, (4) There is a lack of established procedures for recasting general social science knowledge and data into useful forms, (5) There is a lack of communication between social scientists and agency people concerning priorities, (6) State level decision makers show a lack of concern for qualitative matters as opposed to pure numbers, (7) Labelling and a little knowledge can be dangerous.

(Abstracted by Sally Ralston).

8F-2-A Vlachos, E., et al. 1975. Social impact assessment: An overview. U.S. Army Eng. Inst. Water Resources, Kingman Bldg., Fort Belvoir, Va.

The report seeks to present an overview of the basic assumptions, priorities, methodological strategies and techniques procedures of data collection, organization and analysis for conducting social impact assessment as a part of the entire assessment process.

Specific topics addressed include: (1) profiling and modelling human communities, (2) methods and their analysis, (3) assessment and evaluation and (4) management considerations.

(From author's abstract).

G. General Techniques and Methods of Reclamation

8G-1-A Allen, N., Jr. 1973. Experimental multiple seam mining and reclamation on steep mountain slopes, p. 98-104. *In* First Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

The stripping method developed was tested in an actual coal production area where four seams could be stripped and augered. Spoil was placed only on outslopes of 28 degrees in an area limited to 20 feet vertically below the coal elevation. Excess spoil was hauled to a previously mined pit at another nearby site. As stripping and augering progressed, overburden removed from a higher seam was used for fill in the vacated pit. The final slope was graded to approximately 1.5/1 and the reclaimed area hydroseeded as quickly as possible. A 30-foot bench on the outer slope was kept clear of spoil for a roadway for future mining. Some of the problems of spoil handling are discussed, and preliminary trucking costs are given.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-6, p. 79).

8G-2-A Batson, F. T., and J. C. Elliot. 1975. Surface resource inventory of eastern Montana rangelands utilizing high altitude color infrared photography, p. 651-662. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 5. Eastern Montana Coll., Billings.

Since 1972 the BLM has inventoried nearly 3 million acres of land overlying strippable coal reserves in southeastern Montana using small scale color infrared photography. It is the best inventory tool available and provides baseline data from which to assess the actual impact of various kinds of coal development. It provides data on vegetative resources, watershed conditions, surface hydrology, potential wildlife habitat and current land uses. The techniques and interpretation of aerial infrared photography are discussed in detail, giving the characteristic photographic textures and colors of 14 vegetative types, erosion conditions and susceptibility parameters, agricultural plots, surface hydrologic features, porcellanite outcrops and rangeland utilization.

(From author's abstract).

8G-3-A Bingham, E. R., and L. E. Chabot. 1968. White Pine's program. Mining Congr. J. 1968(Aug.):29-32.

Discusses maintenance of environmental quality and reclamation of disturbed lands from total operational standpoint--mine, mill and smelter. Located in northern Michigan.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

8G-4-A Collins, W. G., and P. W. Bush. 1969. An air-photokey for derelict land studies. J. Town Planning Inst. (London) 55(6):246-255.

The authors describe the third stage of applying aerial photographic methods to surveying spoiled lands. In two previous articles they defined derelict land, and constructed an air photokey for use in such studies. Here they examine in detail its application to the whole of an area southeast of Leeds and reconsider some of the earlier work in light of problems presented by this third stage.

(From authors' abstract).

8G-5 Contakos, J. 1962. Restoration of areas affected by coal mining, p. 48-52. *In* Proceedings of the national symposium on the control of coal mine drainage. Pennsylvania Dep. Health Pub. No. 4, Harrisburg, Pa.

8G-6 Cook, L. 1963. New approach to strip land reclamation. Mining Congr. J. 49(8):68-70.

8G-7-A Craig, J., and J. Libicki. 1975. Proceedings of the Polish-U.S. Symposium "Environmental protection in openpit coal mining" held at Denver, Colorado on 27-29 May 1975. Denver Res. Inst., Denver, Colo., and Office Int. Activities, EPA, Washington, D.C. 165 p. (NTIS No. PB-249 300/5ST).

Proceedings of May 27-29 Polish-U.S. Symposium on "Environmental protection of openpit coal mines," contains 18 papers on openpit coal mining, techniques, refuse disposal, hydrology, water purification, run-off, sediment control, uses of fly ash, toxicity of water, waste stabilization, use of byproducts, dewatering techniques, and surface reclamation.

(From NTIS).

8G-8-A Dougherty, M. T., and H. H. Holzen. 1976. Evaluation of surface mine reclamation techniques--Cambell's Run Watershed, Pennsylvania. Pennsylvania Dep. Environmental Resources, Harrisburg, Pa. 61 p. (NTIS No. PB-255 298/2ST).

A study was performed to demonstrate the effectiveness of surface reclamation of strip mined land upon water quality in streams receiving mine drainage pollution from abandoned underground mines. The water quality was monitored in three phases, prior to the surface reclamation, during reclamation, and after reclamation. The results were then evaluated to determine any improvement in water quality resulting from the construction of the abatement facilities.
(From NTIS).

8G-9 Earth Satellite Corporation. 1971. Remote sensing of mined area reclamation: Application inventory. Earth Satellite Corp. 41 p. (NTIS No. PB2-04197).

8G-10-A Environmental Protection Agency. 1973. Processes, procedures and methods to control pollution from mining activities. EPA-430/a-73-011, U.S. Government Printing Office, Washington, D.C. 390 p.

Surface and underground mining are discussed. Items discussed with respect to surface mining are: mining procedures, regrading, erosion control and revegetation.
(From R. K. Honkala. 1974 bibliography. No. 460, p. 45).

8G-11 Foreman, J. W. 1970. Evaluation of pollution abatement procedures in Moraine State Park, p. 304-333. *In* Third symposium on coal mine drainage research. River Valley Water Sanitation Comm., Cincinatti, Ohio.

8G-12-A Griffith, F. E., M. O. Magnuson, and R. L. Kimball. 1966. Demonstration and evaluation of five methods of secondary backfilling of strip-mined areas. Rep. of Investigations No. 6772. Bur. Mines, USDI, Washington, D.C.

Cost data are given for five methods of secondary backfilling of strip mines previously partially backfilled. The operations were conducted in north central Pennsylvania; an average of 600 linear feet of highwall were backfilled in each trial. Major obstacles and the relative merits of the methods are discussed.
(From authors' abstract).
(From British bibliography, unpubl., p. 40).

8G-13-A Hancock, V. B., J. L. Culbertson, R. H. McHugh, J. C. Sherrod, and C. A. Teitz. 1975. Analysis of ecological suitability for multiple-use planning on the Little Missouri National Grassland, p. 672-683. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 5. Eastern Montana Coll., Billings.

A method of analysis of the ecological suitability of local and/or regional areas for various types of development is presented. It provides a systematic, interdisciplinary approach to resource inventories and an assortment of environmental impact from various uses such as strip-mining, power plant development, etc.
(Abstracted by Sally Ralston).

8G-14-A Havens, R., and K. C. Dean. 1969. Chemical stabilization of the uranium tailings at Tuba City, Arizona. Rep. Investigations No. 7288. Bur. Mines, USDI, Washington, D.C.

Acid and basic uranium mill tailings at Tuba City, Arizona were stabilized against wind erosion by use of an elastomeric polymer on the dike areas and a calcium magnesium ligno-sulfate on the beach areas. Cost was $335/acre for the 34.5 acre tract. Details as to methods of application and cost breakdown are given.
(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

8G-15 Hennebry, H. M., and K. L. Diem (Eds.). 1967. Wyoming's natural resources and their management. Wyoming Game and Fish Dep. Tech. Bull. 92 p.

8G-16-A Hodder, R. L. 1973. Surface mined land reclamation research in eastern Montana, p. 82-91. *In* First Research and Applied Technology Symposium on Mined-Land Reclamation. Natl. Coal Assoc./Bitum. Coal Res., Inc., Pittsburgh, Pa.

The author of this article reports that agriculturally-oriented reclamation is composed of five distinct phases: preplanning studies; purpose, design and reclamation plan; development plan, schedule, engineering and shaping; surface manipulation, topsoiling, and revegetation; and management.

Methods of dryland revegetation and planting techniques are discussed.
(From Dalsted and Leistritz. 1973 bibliography. No. E-26, p. 19).

8G-17-A Hyslop, J. 1964. Some present day reclamation problems: An industrialist's viewpoint. Ohio J. Sci. 64(2):157-165.

Concerned with the extraction of coal, the author discusses methods of removing and storing overburden. A large pit remains when operations are finished which may be filled with overburden from other sites (burden transport of material is expensive) or allowed to fill with water.
(From British bibliography, unpubl., p. 41).

8G-18-A Johnson, C. 1966. Practical operating procedures for progressive rehabilitation of sand and gravel sites. Natl. Sand and Gravel Assoc., Silver Spring, Md.

This is a general presentation of operating methods and reclamation of sand and gravel deposits. These are usually exploited in urban areas so the emphasis is on rather intensive development. Some application, especially of the pre-mine planning suggestions, may be made to other mineral development in less populated areas. Equipment characteristics and recommendations are given.
(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

8G-19 Lustig, L. K. 1969. Trend surface analysis of the Basin and Range Province and some geomorphic implications. U.S. Geol. Surv. Prof. Pap. No. 500-D. U.S. Geol. Surv., Washington, D.C. 70 p.

8G-20* May, M. 1975. Moisture relationships and treatments in revegetating strip mines in the arid West.
(See 4A-98).

8G-21* May, R. F. 1964. Surface mine reclamation: Continuing research challenge.
(See 2A-52-A).

8G-22-A Nephew, E. A., and R. L. Spore. 1976. Costs of coal surface mining and reclamation in Appalachia. Oak Ridge Natl. Lab., Tenn. (4832000). 45 p. (NTIS No. ORNL-NSF-EP-86).

Coal surface mining and reclamation costs in Appalachia are estimated as a function of reclamation quality, the angle of natural terrain, and the overburden-to-coal stripping ratio. When mining to a maximum stripping ratio of 20, the cost of providing minimally acceptable, or basic, reclamation is estimated to be $0.49, $0.95, and $1.50/ton of coal mined, for 15 exp 0, 20 exp 0, and 25 exp 0 terrain, respectively. The cost of providing full reclamation under the same conditions is estimated to be $1.59, $3.27, and $5.51/ton of coal mined. The cost of reclamation is also found to increase with the

stripping ratio. When mining to a maximum stripping ratio of 30, the cost of providing basic reclamation is estimated to be $0.65, $1.25, and $1.98/ton of coal mined, for 15 exp 0, 20 exp 0, and 25 exp 0 terrain, respectively. The cost of providing full reclamation under the same conditions is estimated to be $2.09, $4.13, and $7.26/ton of coal mined. Hence, independent of the stripping ratio, the cost of basic reclamation on 25 exp 0 terrain is roughly the same as full reclamation on 15 exp 0 terrain. An empirical formula is presented for predicting coal production and reclamation costs for other conditions of terrain angle, stripping ratio, and levels of reclamation quality. This study was performed to provide quantitative information to policymakers involved in the process of choosing among alternative regulatory programs. The mining and reclamation costs developed do not take into account possible limitations in available coal reserves.
(From NTIS).

8G-23 Ohio Agricultural Research and Development Center. 1966. Restoring land to its productive use, p. 22. *In* Research and development for economic growth, Wooster, Ohio. Agric. Developmental Center Annu. Rep. No. 84. (Ohio Agric. Res. Developmental Center Bull. No. 986, Wooster, Ohio).

8G-24-A Persse, F. H. 1975. Strip-mining techniques to minimize environmental damage in the Upper Missouri River Basin states. Information Circ. (Intermountain Field Operation Center, Denver Colo.) Bur. Mines, USDI, Washington, D.C. 58 p. (NTIS No. PB-245 843/8ST).

To meet escalating energy requirements, substantial increases in production from strippable coal and lignite deposits in eastern Montana, western North Dakota, and northeastern Wyoming already have occurred, and further expansions are expected to continue at least until the year 2000. Such production, attributable largely to rising demand for low-sulfur coal, must be accomplished with a minimum of adverse effects on the environment. Information on geology, climate, and current land use in the Upper Missouri River basin is presented as a guideline to what operators expect during, and after mining. Proven methods of protecting the air and water from pollution and of restoring mined land for other uses are described by the Bureau of Mines. In addition, untried methods of land reclamation, some with equipment yet to be manufactured are discussed as means of maintaining high aesthetic values in the basin. Costs incurred to protect the environment are a legitimate part of the production cost and must be born by the ultimate consumer.

Unit production cost are less for the thick coal and lignite deposits of the basin than for the thinner but higher Btu coal deposits of the eastern and midwestern United States.
(From NTIS).

8G-25* Reilly, J. D. 1965. Planning surface mine reclamation before mining.
(See 6C-89-A).

8G-26-A Schellie, K. L., and D. L. Rogier. 1963. Site utilization and rehabilitation practices for sand and gravel operations. Natl. Sand and Gravel Assoc., Silver Spring, Md.

This is a guide for pre-planning the useful adaptation of land after extraction of minerals. Since it is concerned with sand and gravel operations, the emphasis is on the intensive land uses found in urban areas. However, some of the material is applicable to mining projects involving other minerals in less populated areas. The authors stress long-range pre-use planning to ensure legal availability of deposits and proper subsequent land use. Various land uses and site requirements of each are given. Site improvement practices--involving grading, soils and planting--are described.
(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

8G-27* Struthers, P. H., and J. P. Vimmerstedt. 1965. Advances in stripmine reclamation.
(See 1B-22-A).

8G-28-A Sullivan, G. D. 1967. Current research trends in mined-land conservation. Mining Eng. 19(3):63-67.

This account of reclamation projects includes activities of TVA, Indiana Coal Association, Central States Forest Experiment Station, Purdue University, Kansas State Forestry, Fish and Game Commission, West Virginia Surface Mining and Reclamation Association, and ORSANCO.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R67-12, p. 43).

8G-29 Valentine, J. F. 1971. Range developments and improvements. Brigham Young Univ. Press, Provo, Utah. 516 p.

8G-30-A Waldbieser, W. C. 1968. Development of equipment for cast overburden reclamation. Mining Congr. J. 54(7):50-51.

Reviews the need for more economical equipment or methods for the reclamation phase of strip-mining operations. Discusses enlarged trenchers or backhoes, use of booster draglines and wheel excavators.

(From T. H. W. Loomis. 1971 bibliography. Bur. Land Manage.).

8G-31 Wobber, F. J., and D. Garofalo. 1971. Remote sensing for mined area reclamation: Applications inventory. Bur. Mines, USDI, Washington, D.C. 40 p.

8G-32 Woodley, R. A., and S. L. Moore. 1967. Pollution control in mining and processing of Indiana coal. J. Water Pollut. Control Federation 39(1):41-49.

IX. COMPUTER MODELS AND PROGRAMS

9-1 Abraham, C. E. 1975. Computer use for river regulation. J. Hydraulics Div. ASCE 101(HY2):291-297.

9-2* Bickel, D. 1975. Computerized data file of Rocky Mountain and Northern Plains mollusks for endangered species surveys and environmental analysis: A preliminary report. (See 3E-3-A).

9-3 Chen, C. S., and B. L. Davis (Eds.). 1974. A possible decrease in rainfall from coal-fired power plant effluent as suggested by a numerical modeling experiment, p. 151-154. *In* Symposium on atmospheric diffusion and air pollution. Am. Meteorol. Soc., Boston, Mass. (Held at Santa Barbara, Calif., 8-13 Sept. 1974).

9-4 Coutant, C. C., and C. R. Cole. 1968. Modelling of aquatic systems, p. 9-30. *In* R. C. Thompson, P. Teal, and E. G. Swegea (eds.) Pacific Northwest Laboratory Annual Report for 1967 to USAEC Division of Biology and Medicine. Vol. 1, Biological Sciences. Battelle Northwest Lab. Rep. No. BNWL-714. Richland, Wash.

9-5-A Dooley, J. M. 1975. Application of U.S. Bureau of Reclamation water surface profile program (WSP), p. 138-154. *In* W. F. Clark (ed.) Proceedings of the Fort Union Coal Field Symposium. Vol. 2. Eastern Montana Coll., Billings.

A program has been developed to determine the stream maintainence flows for streams and rivers. Only one set of field measurements of flow velocity, flow quantities, water depths, water surface elevations and cross-sectional area is required for the determination of minimum stream flow of individual segments. It allows the user to predict and/or study various changes in stream characteristics at many different flows. It is calibrated to a specific stream section using observed physical parameters. The use and output of this program are described.
(Abstracted by Sally Ralston).

9-6 Greenberg, M. R., D. A. Krueckeberg, and R. Mautner. 1973. Long range projections for minor civil divisions: Computer programs and user's manual. Center for Urban Policy Res., Rutgers Univ., New Brunswick, N.J.

9-7 Hyatt, M. L. 1970. Computer simulation of the hydrologic-salinity flow system within the Upper Colorado Basin. Utah Water Res. Lab., Utah State Univ., Logan.

9-8* Jeppson, R. W., et al. 1974. Slope stability of overburden spoil dumps from surface phosphate mines in southeast Idaho.
(See 1C-14-A).

9-9 O'Leary, M., R. H. Lippert, and O. T. Spitz. 1966. FORTRAN IV and map program for computation and plotting of trend surfaces for degree 1 through 6. Kansas Geol. Surv. Computer Contrib. No. 3. Topeka, Kans.

9-10-A Otte, J. A., and M. Boehlje. 1975 A model to analyze the costs of strip mining and reclamation. *In* Third Symposium on Surface Mining and Reclamation. Vol. 2. Natl. Coal Assoc./Bitum. Coal Res., inc., Louisville, Ky. 19 p. (NTIS No. IS-ICP-3).

Recent developments in mining techniques, materials handling methods and reclamation procedures have increased the alternatives available to the strip mine operator. A user-oriented computer program has been developed to assist the miner in the cost analysis of the different equipment and equipment combinations in alternative overburden and pit configurations. The model calculates production and cost for each individual task performed to uncover and remove coal and reclaim the surface for productive use. Total costs per ton of coal removed and the capital outlay required to obtain a specified level of annual production are also determined. Several sizes and types of equipment can be analyzed to select the optimal equipment set before the miner operator commits his capital. Illustrative results indicate the detail of the information generated by the model and the impact of overburden characteristics and depth, machine size and theoretical versus actual production on mining and reclamation costs.
(From NTIS).

9-11 Peikert, E. W. 1963. IBM-709 Program for least squares analysis of three dimensional geological and geophysical observations. Office Naval Res., Geogr. Branch Tech. Rep. No. 4, ONR Task No. 389-135. Dep. Navy, Washington, D.C.

9-12 Polzin, P. E. 1973. Urban employment models: Estimation and interpretation. Land Econ. 49(5):226-233.

9-13-A Smith, V. E. 1974. Surface water system--1973. Water Resources Res. Inst.. WRRI Ser. No. 43. Univ. Wyoming, Laramie.

Computer statistical and hydrological analysis of surface water data in Wyoming.
(Abstracted by Sally Ralston).

9-14* Wlosinski, J. H., and C. B. Stalnaker. 1974. Development and analysis of a general stream simulation technique.
(See 3E-53-A).

X. OPTIONS AND ALTERNATIVES TO MINING TECHNIQUES

10-1-A Anonymous. 1973. Pollution control: An alternative to strip mining. Business Week 2298(Sept. 22):32Z, 32B1, 32F1.

A new kind of longwall mining would avoid acid drainage and scarring.

(From R. K. Honkala. 1973 bibliography. No. 448, p. 44).

10-2 Council on Environmental Quality. 1975. MERES and the evaluation of energy alternatives. Council on Environmental Quality, U.S. Government Printing Office, Washington, D.C.

10-3-A Gentry, D. W., and G. T. Bator. 1974. Evaluation of mining techniques, p. 25-29. *In* C. W. Cook (ed.) Surface rehabilitation of land disturbances resulting from oilshale development. Colorado State Univ. Information Ser. No. 11. Range Sci. Dep., Colorado State Univ., Fort Collins.

Mining techniques are described and compared to their applicability to various areas of the Piceance Basin. Advantages and disadvantages of each technique are given.

The methods discussed are: (1) Underground: room and pillar; block caving, occidental processing; and shafts and adits. (2) Surface mining. (3) In situ processing.

(Abstracted by Sally Ralston).

10-4* Persse, F. H. 1975. Strip-mining techniques to minimize environmental damage in the Upper Missouri River Basin states.

(See 8G-24-A).

10-5 Zube, E. 1966. A new technology for taconite badlands: New mining techniques offer a chance to do more than create a "moonscape" in Wisconsin. Landscape Architecture 56(2): 136-140.

XI. SYMPOSIA AND CONFERENCES

11-1 American Institute of Mining, Metallurgical and Petroleum Engineers. 1968. Proceedings of the Second International Surface Mining Conference. Am. Inst. Mining, Metallurgical Petroleum Eng., New York, N.Y. 322 p. (Held in New York, N.Y., 18-20 Sept. 1968).

11-2-A Bureau of Mines and Bureau of Outdoor Recreation. 1973. Proceedings of the regional conference on surface-mined land for outdoor recreation. Bur. Mines and Bur. Outdoor Recreation, USDI, Washington, D.C. 124 p.

The two-day session contained many papers covering all phases of reclamation with emphasis of land use for recreational purposes.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-113, p. 101).

11-3-A Bureau of Outdoor Recreation. 1973. Proceedings of the national conference on reclamation of surface-mined lands for outdoor recreation. Outdoor Recreation Action Rep. No. 28. Bur. Outdoor Recreation, USDI, Washington, D.C. 48 p.

This booklet contains proceedings of the First National Conference on Reclamation of Surface-Mined Lands for Outdoor Recreation held in Washington, D.C., May 14 and 15, 1973. Also included is information on federal and state organizations and administration and on federal, state and local financing of outdoor recreation.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-101, p. 99).

11-4* Council of State Governments. 1964. Conservation and land use in the surface coal mine industry. (Mined Land Conservation Conference, "Surface mining: Extent and economic importance, impact on natural resources, and proposals for reclamation of strip-mined lands.") (Held at Roanoke, Va., 13-14 April 1964).
(See 6A-15-A).

11-5 Craig, P. P. (Ed.). 1972. Cornell workshop on energy and the environment. Cornell Univ., Ithaca, N.Y. 246 p.

11-6 Currier, W. F., and D. L. Merkel (Co-chairmen). 1973. Proceedings of the critical areas stabilization workshop. Rep. 7A, New Mexico Inter-Agency Range Comm., Agric. Res. Serv., USDA, Las Cruces, N.M. 197 p.

11-7 Dambach, C. A., and O. D. Diller. 1964. Introduction: A symposium on strip mine reclamation held at Wooster, Ohio. Ohio J. Sci. 64(2):64-175.

11-8-A Department of Natural Resources, Kentucky. 1967. Strip mining symposium. Div. Reclamation, Dep. Nat. Resources, Kentucky. (Held at Owensboro, Ky., 13-14 July 1967).

Contains papers on policy, current research in all areas of reclamation, economics of stripmining and the advantages of reclamation.
(Abstracted by Sally Ralston).

11-9-A Georgia Surface Mined Land Use Board. 1971. Symposium on rehabilitation of drastically disturbed surface mined lands. Georgia Surface Mined Land Board, Macon, Ga. 126 p. (4-5 Nov.).

The problems of reclamation of surface mined land are treated generally although there are a number of mentionals of kaolin mining since that is one of Georgia's largest surface mining industries. Among subjects discussed in various papers are land use planning, legislative requirements for reclamation, vegetation, water and erosion control, dust control, developing lands for fishing, or sanitary land fills.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R71-44, p. 63).

11-10-A Hartman, H. L. (Ed.). 1969. Case studies of surface mining. Proceedings of the 2nd International Surface Mining Conference. Am. Inst. Mining Eng., New York, N.Y. 322 p. (Held at Minneapolis, Minn., 18-20 Sept. 1968).

Discussion of surface mining in several countries. Multiple use of mined land is discussed in the Ohio Coal Company's mine expansion program.
(Abstracted by Sally Ralston).

11-11-A Hocking, D., and W. R. MacDonald (Eds.). 1974. Proceedings of a workshop on reclamation of disturbed lands in Alberta. Northern For. Res. Center Information Rep. No. NOR-X-116. (27-28 March 1974).

There are several sections of discussion pertinent to coal stripmining impacts, including the selection of plants for the revegetation of disturbed lands and the reclamation of coal spoils.
(Abstracted by Sally Ralston).

11-12 Hutnik, R. J., and G. Davis (Eds.). 1973. Ecology and reclamation of devastated land: Proceedings of a NATO Advanced Study Institute on the ecology and revegetation of drastically disturbed lands. Vol. 1 and 2. Gordon and Breach, New York, N.Y. Vol 1: 583 p. Vol. 2: 504 p. (Held at Pennsylvania State Univ., University Park, 3-6 Aug. 1969).

11-13-A Kansas Geological Survey. 1971. Mined-land re-development workshop. Kansas Geol. Surv. Spec. Distribution Publ. No. 58. Topeka, Kans. 48 p.

The workshop proceedings include the following papers:
Hambleton, W. W., "The geological context of mined-land redevelopment," p. 5-7.
Camin, K. Q., "An action plan for redeveloping southeast Kansas lands," p. 9-14.
Murphy, L., "Effects of fly-ash as a soil amendment on strip-mined soils," p. 15-20.
Grandt, A. F., "Agriculture crops on mined lands," p. 21-24.
Hyde, R. M., "Mined land reclamation," p. 25-28.
Capp, J. P. and Adams, L. M., "Reclamation of acid spoil with power plant fly ash," p. 29-39.
Kovacic, W., "Fly ash research test plots," p. 41-42.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R71-27, p. 59-60).

11-14-A Kansas Geological Survey. 1972. 1972 mined land workshop proceedings. Kansas Geol. Surv. Spec. Distribution Publ. No. 65. 29 p.

Papers presented at the workshop include:
Boyee, L., "Results of soil stabilization tests with fly ash and calcium sulfate sludge," p. 3-6.
Jurgens, L., "Suitable plant materials for various uses on reclaimed mined land in southeast Kansas," p. 7-9.
Stewart, E. L., Jr., "Mined land redevelopment as a demonstration. Where do we go from here?" p. 9-11.
Edwards, J., "The leisure industry in its total concept," p. 11-14.
Geyer, W. A., "Mined land potential for raising timber crops," p. 18-21.
Camin, K. Q., "Data collected from the demonstration sites," p. 21-23.
McClain, T. J., "Preliminary results of hydrologic studies in southeastern Kansas coal fields," p. 24-26.
Kovacic, W. J., "The use of fly ash on the acid soil of reclaimed mined land," p. 26-27.

Immich, C., "Metal recovery from coal ash to defray costs of mined land reclamation," p. 28-29.
There is also a map of selected reclamation sites in Kansas.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R72-43, p. 72).

11-15 Lessler, M. A. 1975. Symposium on biological implications of strip mining. Ohio J. Sci. 75(6):265-319. (Held at Columbus, Ohio, 15-16 Nov. 1974).

11-16 Mellon Institute. 1965. Symposium on acid mine drainage research. Mellon Inst., Pittsburgh, Pa.

11-17 Mellon Institute. 1968. Second symposium on coal mine drainage research. Sponsored by Coal Industry Advisory Comm. to the Ohio Valley Water Sanitation Commission and Mellon Inst., Pittsburgh, Pa. 406 p. (14-15 May 1968).

11-18 Mellon Institute. 1970. Third symposium on coal mine drainage research. Sponsored by Ohio River Valley Water Sanitation Commission and Mellon Inst., Pittsburgh, Pa. (19-20 May 1970).

11-19-A National Coal Association. 1973. First research and applied technology symposium on mined-land reclamation. Natl. Coal Assoc., Washington, D.C. (Held at Pittsburgh, Pa., 7-8 March 1973).

The papers presented covered many aspects of reclamation. Standard reclamation, consideration of grading, soil amendments, plant material and planting methods were presented. The topics of pre-planning the mining operation and mining operating procedures also were discussed along with utilization and management of mined lands.
(From Dalsted and Leistritz. 1973 bibliography. No. E-46, p. 22).

11-20-A National Coal Association. 1973. Selected papers and remarks from the research and applied technology symposium on mined-land reclamation. Natl. Coal Assoc., Washington, D.C. 150 p.

A selection of twelve papers given at the Mined-Land Symposium in Pittsburgh, March 1973.
(Abstracted by Sally Ralston).

11-21 National Coal Association. 1974. Second research and applied technology symposium on mined-land reclamation. Natl. Coal Assoc., Washington, D.C.

11-22 National Coal Association. 1974. Fifth symposium on coal mine drainage research. Natl. Coal Assoc., Washington, D.C.

11-23-A Northeastern Forest Experiment Station. 1973. Forest fertilization symposium proceedings. U.S. Forest Serv. Gen. Tech. Rep. NE-3. Northeast. For. Exp. Sta., Upper Darby, Pa. 246 p.

A collection of papers presented at the Forest Fertilization Symposium held in August, 1972 at the Pack Forest, Warrensburg, N.Y., by the Northeastern Forest Soils Conference, Sponsored by the U.S. Forest Service and Canadian Forestry Service, with cooperation of the State University of New York College of Forestry. (From author's abstract).

11-24 Pennsylvania State University. 1965. Proceedings of the coal mine spoil reclamation: Scientific planning for regional beauty and prosperity. School For., Coll. Agric., Pennsylvania State Univ., University Park. (12-13 Oct. 1965).

11-25-A Pennsylvania State University. 1971. Ecology of devastated land: International symposium on the characteristics of reclamation of mined-land. Pennsylvania State Univ., University Park.

Contains 66 papers presented covering the topics of the characteristics and reclamation of mined land. (Abstracted by Sally Ralston).

11-26 Peter, W. C. (Ed.). 1970. Conference on mining and ecology in arid environments. Coll. Mines, Univ. Arizona, Tucson. 229 p. (22-27 March 1970).

11-27 Pfleider, E. R. (Ed.). 1968. Seeley W. Mudd fund series. Am. Inst. Mining, Metallurgical and Petroleum Eng., Inc., New York, N.Y.

11-28 Wali, M. K. 1975. Practices and problems of land reclamation in western North America. Univ. North Dakota Press, Grand Forks. 196 p. (Held at Grand Forks, N.D., 20-21 Jan. 1975).

11-29-A West Virginia University. 1971. Proceedings on revegetation and economic use of surface mined land and mine refuse symposium. School Mines, Coll. Agric. For., Appalachian Center, West Virginia Univ., Morgantown. 59 p. (Held at Pipestem Park, W. Va., 2-4 Dec. 1971).

The proceedings include the following papers on surface-mined land reclamation:
Glover, F. W., Jr., "Surface mine reclamation-preplanning;"
Smith, R. M., "Properties of coal overburden that influence revegetation and economic use of mine soils;"

Anderson, J. C., "Preparation of surface-mined land for revegetation;"
Plass, W. T., "Highwalls--an environmental nightmare;"
Vogel, W. G., "Needs in revegetation research on surface-mined lands;"
Balasko, J. A., "Plant and spoil characteristics affecting surface mine revegetation;"
Vande Linde, O. V., Jr., "Vegetation and techniques currently used in revegetation of surface-mined land;"
Bennett, O. L., "Grasses and legumes for revegetation of strip-mined areas;"
Brown, J. H., "Use of trees for revegetation of surface-mined areas;"
Hardin, N. C., "Use of specialty crops for revegetation on surface mine areas;"
Rawson, J. W., "Surface mining and wildlife;"
Curtis, W. R., "Vegetating strip-mine spoils for runoff and erosion control;"
Sperow, C. B., Jr., "Continuing management of vegetation on surface-mined land;"
Sutton, P., "Continuing management of vegetation on surface-mined land;"
Eigenbrod, W. F., "Use of stabilizers and binders for conditioning surface-mined land and coal mine refuse for revegetation;"
Capp, J. P. and Adams, L. M., "Reclamation of coal mine wastes and strip spoil with fly ash;"
Ozmina, D. J., "Industry experience in revegetating with grasses, legumes and related plants;"
Smith, W. D., "Industry experience in revegetating with trees;"
Frederick, G. B., "Industry experience in revegetating with specialty crops."

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R71-30, p. 60-61).

XII. BIBLIOGRAPHIES

12-1 Averitt, P., I. A. Breger, H. J. Gluskoter, V. E. Swanson, and P. Zubovic. 1972. Minor elements in coal--A selected bibliography. U.S. Geol. Surv. Res. Prof. Pap. 800-D. U.S. Geol. Surv., Washington, D.C. p. D169-D171.

12-2 Berg, R. B. 1971. Index of graduate theses on Montana geology. Montana Bur. Mines and Geol., Butte, Mont. 448 p. (SP54).

12-3 Berg, R. B. 1973. Current geological and geophysical studies in Montana. Montana Bur. Mines and Geol., Butte, Mont. 17 p.

12-4* Bergoffen, G. S. 1962. Strip-mine reclamation: A digest. (See 6A-5-A).

12-5-A Bituminous Coal Research, Inc. (Compiler). 1962-1969. Mine drainage abstracts--A bibliography. Bituminous Coal Res., Inc. Supplements, Natl. Coal Assoc., Monroeville, Pa.

Four booklets of references to all aspects of the impact of mining on water resources and water quality. Excellent abstracts.
(Abstracted by Sally Ralston).

12-6-A Bituminous Coal Research, Inc. (Compiler). 1975. Reclamation of coal mined-land: A bibliography with abstracts. Bituminous Coal Res., Inc. and Natl. Coal Assoc., Monroeville, Pa. 188 p.

Gives abstracts of literature dealing with the reclamation of coal stripmined lands. Over 700 abstracts arranged by the year of publication with author and general indexes.
(Abstracted by Sally Ralston).

12-7 Botz, M. K., and E. W. Bond. 1966. Index and bibliography of groundwater studies in Montana. Montana Bur. Mines and Geol., Butte, Mont. (SP37).

12-8-A Bowden, K. L. 1961. A bibliography of strip-mine reclamation, 1953-1960. School Nat. Resources, Univ. Michigan, Ann Arbor. 13 p.

There are 152 references in this update of Limstrom's "A Bibliography of Strip-mine Reclamation" published in 1953.
(Abstracted by Sally Ralston).

12-9-A Caldwell, N. B. 1974. An annotated bibliography of the surface-mined area restoration research project. Northeast. For. Exp. Sta. U.S. Forest Serv., Washington. D.C. 22 p.

An annotated bibliography including a total of 81 references and an author index.
(Abstracted by Sally Ralston).

12-10-A Dalsted, N. L., and F. L. Leistritz. 1973. A selected bibliography on surface coal mining and reclamation of particular interest to the Great Plains states. Agric. Econ. Misc. Rep. No. 15. Dep. Agric. Econ. and North Dakota Agric. Exp. Sta., North Dakota Univ., Fargo. 43 p.

This report represents a continuation of study of the socio-economic impact of coal development in North Dakota. Contains specific listings for surface coal mining, economic impact of strip mining and environmental impact of strip mining, among others. (A total of 270 references).
(From author's foreword).

12-11 Environmental Protection Agency. 1973. A preliminary bibliography of publications concerning rehabilitation of lands disturbed by mining and associated activities for the Northern Great Plains research program. EPA, Rocky Mountain Prairie Region, Denver, Colo.

12-12-A Frawley, M. L. 1971. Surface mined areas: Control and reclamation of environmental damage--A bibliography. Bibliogr. Ser. No. 27. USDI, Washington, D.C. 63 p.

Deals only with literature published in the U.S. between 1960 and 1970.
(Abstracted by Sally Ralston).

12-13-A Funk, D. T. 1962. A revised bibliography of strip-mine reclamation. Central States For. Exp. Sta. Misc. Release No. 35. U.S. Forest Serv. (Columbus, Ohio). 20 p.

172 references dealing primarily with vegetation and reclamation.
(Abstracted by Sally Ralston).

12-14-A Gifford, G. F., D. D. Dwyer, and B. E. Norton. 1972. A bibliography of literature pertinent to mining reclamation in arid and semi-arid environments. The Environment and Man Program, Utah State Univ., Logan, Utah. 23 p.

This compilation of 312 references covers reclamation from all types of mining. The references are categorized

and the section covering coal spoil banks only has 34 references, but there are many coal related references in other categories.
(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R72-18, p. 67).

12-15 Hodder, R. L., B. W. Sindelar, J. Bucholz, and D. E. Ryerson. 1971. Coal mine spoils reclamation research project, Western Energy Co., Colstrip, Montana. Res. Rep. No. 8, Montana Agric. Exp. Sta., Bozeman. 56 p.

12-16-A Hoffman, G. J., R. B. Curry, and G. O. Schwab. 1964. Annotated bibliography on slope stability of strip mine spoil banks. Ohio Agric. Exp. Sta. Res. Circ. No. 130. Columbus, Ohio.

Contains 366 references arranged alphabetically.
(Abstracted by Sally Ralston).

12-17* Honkala, R. K. 1974. Surface mining and mined land reclamation--A selected bibliography.
(See 6D-10-A).

12-18-A Kieffer, F. V. 1972. A bibliography of surface coal mining in the United States to August, 1971. Forum Assoc., Columbus, Ohio. 71 p.

References organized by: (1) books; (2) academic publications and symposium proceedings; (3) Federal government publications; (4) master's theses and doctorate dissertations; (5) newspaper articles; (6) popular magazines; (7) professional and scholarly journals; (8) state government publications; and (9) trade journals.
(Abstracted by Sally Ralston).

12-19 Knabe, W. 1958. Contributions to the bibliography of reclamation of mined areas. Wiss. Z. Humboldt-Univ. Berl. Math-Naturwiss. Reihe 1958:291-304. (In German with English, French, and Russian summaries).

12-20 Limstrom, G. A. 1953. A bibliography of strip mine reclamation. Central States For. Exp. Sta. Misc. Release No. 8. U.S. Forest Serv. (Columbus, Ohio). 25 p.

12-21* Loomis, T. H. W. 1971. Compiled research data on reclamation of disturbed lands in the western United States, 1970.
(See 6D-13-A).

12-22 Lorenz, W. C. 1962. Progress in controlling acid mine water: A literature review. U.S. Bur. Mines Ser. Information Circ. No. 8080. Bur. Mines, USDI, Washington, D.C. 40 p.

12-23 Munn, R. F. 1965. The coal industry in America: A bibliography and guide to studies. West Virginia Univ., Morgantown.

12-24-A Munn, R. F. 1973. Strip mining--An annotated bibliography. West Virginia Univ., Morgantown. 110 p.

The 611 citations are separated into several categories including History, Government Regulation, The Controversy Over Stripping, Environmental Effects, and Reclamation. The index covers both authors and subjects.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R73-97, p. 98).

12-25 National Coal Board (England). 1967. Plant growth on pit heaps--A literary survey. Tech. Intelligence Branch, Res. Development Dep., Natl. Coal Board, England. 38 p. (Confidential Rep.).

12-26-A National Coal Board (England). 1968. Weathering of sedimentary rocks and mining spoils. Tech. Intelligence Branch, Res. Development Dep., Natl. Coal Board, England. 23 p.

39 references cover (1) weathering of sedimentary rocks in situ; (2) weathering of minerals; and (3) weathering of spoil on pit heaps.

(Abstracted by Sally Ralston).

12-27 Parsons, J. D. 1957. Literature pertaining to formation of acid mine wastes and their effect on the chemistry and fauna of streams. Trans. Ill. Acad. Sci. 50:49-59.

12-28* Peterson, H. B., and R. Monk. 1967. Vegetation and metal toxicity in relation to mine, mill and smelter wastes. (See 4A-104-A).

12-29 Siehl, G. H. (Compiler). 1974. Strip mining, selected references, 1970-1973. Environmental Policy Div., Congr. Res. Serv., Library of Congress, Washington, D.C.

12-30 Steen, C., and W. A. Berg. 1975. Bibliography pertinent to disturbance and rehabilitation of alpine and subalpine lands and the southern Rockies. Colorado State Univ. Information Ser. No. 14. Environmental Resources Center, Colorado State Univ., Fort Collins. 104 p.

12-31-A University of Pittsburgh. 1972. A selected bibliography and discussion of the effects of strip mining upon navigable waters and their tributaries. Graduate Center for Public Works Admin., Univ. Pittsburgh for Corps of Engineers, U.S. Dep. Army. Univ. Pittsburgh, Pittsburgh, Pa. 94 p.

The emphasis of this review of the literature is on the sedimentation and acid mine drainage attributable to strip mining for coal.

(From "Reclamation of Coal-Mined Land: A Bibliography with Abstracts." 1975. No. R72-60, p. 76).

12-32 Walker, F. K. 1974. Bibliography and index of U.S. Geological Survey publications relating to coal, January 1971 - June 1974. U.S. Geol. Surv. Circ. No. 709. U.S. Geol. Surv., Washington, D.C. 18 p.

12-33-A Western Regional Coordinating Committee. 1975. Bibliography pertaining to vegetational establishment and management on lands disturbed by mining in the western states. *In* Massive displacement of land from coal and oil shale development. Western Regional Coordinating Comm. Rep. No. WRCC-21. 6 p.

The objective is to provide an up-to-date list of recent publications plus some of the more appropriate general references and references to lands disturbed by processes other than mining. Publications dated prior to 1970 have been arbitrarily ommitted.

(From author's statement of objectives).

12-34 West Virginia University. (Year unknown). Appalachian bibliography. West Virginia Univ., Morgantown. (2 vol.).

INTRODUCTION
PART II

This section contains a Significant Word in Title (SWIT) index to the bibliography found in Part I. Both the bibliography and the SWIT index were prepared under WELUT contract No. 14-16-0008-2107, "A Simulation Approach to the Analysis of Strip-Mining Impact on the Ecosystem with Emphasis on Wildlife."

A SWIT index is an alphabetized permuted title index. It can be thought of as being a keyword index, the only difference being that the "key words" are generated from the titles in the bibliography rather than being supplied to the program. Every word in every title, unless it has been designated as a "stop word" by the person generating the index, becomes a "key word". Most titles contain words which are not of value as entry points to the bibliography. We have attempted to identify these and designate them as stop words so that they will not appear as key words in the index. Obvious candidates for stop words were pronouns, articles and many words denoting relationships (above, effects, cause, relation, etc.). We have also included as stop words those words which appear in so many titles that they lose the power to discriminate usefully among articles. Words such as "coal", "strip" and "mine" have been designated as stop words for this reason.

The remaining significant words appear alphabetically on the left-hand side of the page. Each significant word is followed by the title of an article containing the word, its author, date of publication and reference number in the bibliography.

To use the index, select a word which represents the subject in which you are interested and locate it in the left-hand column of the index. Note the titles associated with the word. If any title appears promising, note its reference number and note if an abstract of the article appears in the bibliography. Articles which have abstracts are denoted by an "A" suffixed to the reference number. Find the reference number in the bibliography to obtain the complete citation and/or abstract.

SIGNIFICANT-WORD	ARTICLE	REFERENCE
ABANDONED	EROSION FROM ABANDONED COAL HAUL ROADS. (WEIGLE 1966)	1C-24-A
ABANDONED	NATURAL REVEGETATION OF ABANDONED PLOWED GROUND IN MIXED PRAIRIE ASSOCIATION OF NORTH EASTERN COLORADO. (COSTELLO 1949)	4E-24
ABANDONED	SEEDING OF ABANDONED CROPLANDS IN THE CENTRAL GREAT PLAINS. (BEMENT, ET. AL. 1965)	8D-6
ABATEMENT	ABATEMENT OF MINE DRAINAGE POLLUTION IN THE ROCKY-MOUNTAINS. (PUGSLEY, ET. AL. 1970)	6C-86
ABATEMENT	EVALUATION OF POLLUTION ABATEMENT PROCEDURES IN MORAINE STATE PARK. (FOREMAN 1970)	8G-11
ABRAM	EXPERIMENT IN GRASSLAND ESTABLISHMENT ON COLLIERY SHALE, BRICKERSHAW RESERVOIR SITE, ABRAM. 1954-1960. (COATES 1960)	4A-28-A
ABSORPTION	THE INFLUENCE OF PYRITE OXIDATION PRODUCTS ON THE ABSORPTION OF PHOSPHATE OF COAL-MINE WASTE. (PULFORD AND DUNCAN 1975)	2B-23
ABSTRACTS	MINE DRAINAGE ABSTRACTS A BIBLIOGRAPHY. (BIT COAL RES INC 1962-1969)	12-5-A
ABSTRACTS	RECLAMATION OF COAL MINED-LANDO A BIBLIOGRAPHY WITH ABSTRACTS. (BIT COAL RESEARCH INC 1975)	12-6-A
ABUNDANCE	SOIL AND VEGETATION AS LIMITING FACTORS IN COTTONTAIL RABBIT ABUNDANCE. (SAGAR 1962)	5E-57
ACCOMPLISHMENT	OIL SHALE ACCOMPLISHMENT PLAN. (ENVIR. PROT. AGENCY 1974)	7B-7-A
ACCUMULATION	ACCUMULATION OF 32P AND 65ZN BY LIVING AND KILLED PLANKTON. (CUSHING AND WATSON 1968)	3E-12
ACHIEVABLE	RECLAMATION REQUIREMENTS MAY NOT BE ACHIEVABLE. (VAN SWEARINGTON 1975)	6D-27
ACID	EFFECTS OF ACID MINE DRAINAGE ON WATER QUALITY OF A RESERVOIR. (BREZINA, ET. AL. 1970)	1A-5-A
ACID	PLANT-TOXIC CHEMICALS ON ACID SPOILS. (BERG 1965)	2A-5
ACID	AVAILABILITY OF NITROGEN TO PLANTS IN ACID COAL MINE SPOILS. (CORNWELL AND STONE 1968)	2A-21-A
ACID	COPPER, NICKEL, AND ZINC RELEASED FROM ACID MINE SPOIL MATERIALS OF EASTERN KENTUCKY. (MASSEY AND BARNHISEL 1972)	2A-49-A
ACID	EXTRACTABLE SULPHATES AND IRON IN STRIP MINE SPOIL ACID SPOTS. (WILSON AND HEDRICK 1960)	2A-83-A
ACID	TOXICITY OF ACID COAL MINE SPOILS TO PLANTS. (BERG AND VOGEL 1973)	2B-2-A
ACID	BACTERIAL ECOLOGY OF STRIP MINE AREAS AND ITS RELATIONSHIP TO THE PRODUCTION OF ACID MINE DRAINAGE. (DUGAN 1975)	2B-9
ACID	ROOT GROWTH IN ACID SOIL. (WIND 1957)	2B-34
ACID	CHEMICAL ASPECTS OF ACID MINE DRAINAGE. (BARNES AND ROMBERGER 1968)	3A-2
ACID	MINE ACID CONTROL. (BRALEY 1961)	3A-3-A
ACID	RECOVERY FROM ACID MINE POLLUTION IN FOUR STRIP MINED LAKESO SUMMARY PROGRESS REPORT 1967-1968. (CAMPBELL, ET. AL. 1965)	3A-6
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ACID	EVALUATION OF FACTORS AFFECTING ACID MINE DRAINAGE PRODUCTION FROM VARIOUS STRATA OF THE ALLEGHENY GROUP AND THE GROUND WATER INTERACTIONS IN SELECTED AREAS IN WESTERN PENNSYLVANIA. (CARUCCIO AND PARIZEK 1967)	3A-8
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ACID	ACID DRAINAGE AND THE STREAM ENVIRONMENT. (KIMMEL AND SHARPE 1973)	3A-17-A
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ACID	AN ECOLOGICAL APPROACH TO ACID MINE POLLUTION CONTROL. (WALSH 1970)	3A-35
ACID	ACID MINE DRAINAGE POLLUTION CONTROL DEMONSTRATION PROGRAMSO USE OF EXPERIMENTAL WATERSHEDS. (BULLARD 1965)	3B-3-A
ACID	MICROBIAL FACTOR IN ACID MINE DRAINAGE FORMATIONO A PILOT STUDY. (BAKER AND WILSHIRE 1970)	3C-3

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ACID	WATER POLLUTION STUDIES IN ACID STRIP MINED LAKESO CHANGES IN WATER QUALITY AND COMMUNITY STRUCTURE ASSOCIATED WITH AGING. (CAMPBELL, ET. AL. 1965)	3C-12
ACID	FISH DISTRIBUTION IN RELATION TO ACID MINE DRAINAGE. (COOPER 1966)	3C-16
ACID	LIMNOLOGY AND FISHERIES PRODUCTION OF ACID AND ALKALINE STRIP MINE LAKES. (GASH 1968)	3C-27
ACID	THE ECOLOGY AND SUCCESSION OF A GROUP OF ACID AND ALKALINE STRIP MINE LAKES IN CENTRAL MISSOURI. (HEATON 1951)	3C-33
ACID	ACID STRIP MINE LAKE RECOVERY. (KING, ET. AL. 1974)	3C-35-A
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ACID	COMMUNITY METABOLISM IN ACID AND ALKALINE STRIP MINE LAKES. (LIND AND CAMPBELL 1970)	3C-43
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ACID	THE EFFECTS OF ACID STRIP MINE EFFLUENTS ON THE ECOLOGY OF A STREAM. (PARSONS 1968)	3C-54
ACID	A BIOLOGICAL APPROACH TO THE STUDY AND CONTROL OF ACID MINE POLLUTION. (PARSONS 1951)	3C-55
ACID	LIMNOLOGY OF ACID MINE IMPOUNDMENTS. (RILEY 1965)	3C-60
ACID	THE EFFECTS OF ACID MINE DRAINAGE ON THE FISH POPULATION OF GOOSE CREEK, CLAY COUNTY, KENTUCKY. (TURNER 1958)	3C-75-A
ACID	ACTIVITY OF MICROORGANISMS IN ACID MINE WATER ON AEROBIC HETEROTROPHS OF A NORMAL STREAM. (TUTTLE, ET. AL. 1968)	3C-76
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ACID	ACID MINE DRAINAGE MANUAL. (BRANT AND MOULTON 1960)	3E-6
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ACID	THE RECOVERY OF STREAM MACROBENTHIC COMMUNITIIES FROM THE EFFECTS OF ACID MINE DRAINAGE. (HERRICKS AND CAIRNS 1972)	3E-21-A
ACID	THE FAUNA OF AN ACID STREAM. (JEWELL 1922)	3E-26
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ACID	SOME FACTORS AFFECTING THE RESISTANCE OF RAINBOW TROUT TO ACID WATERS. (LLOYD AND JORDAN 1964)	3E-33
ACID	THE REVEGETATION OF HIGHLY ACID SPOIL BANKS IN THE BITUMINOUS COAL REGION OF PENNSYLVANIA. (HORN AND WARD 1969)	4A-73
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ACID	SELECTING GRASSES AND LEGUMES FOR COVER ON ACID STRIP MINE SPOILS. (VOGEL AND BERG 1966)	4B-30
ACID	THE GROWTH OF BROWN TROUT IN ACID AND ALKALINE WATER. (CAMPBELL 1961)	5E-11
ACID	THE FAUNA OF AN ACID STREAM. (JEWELL 1922)	5E-32
ACID	HYBRID POPLAR GROWS POORLY ON ACID SPOIL BANKS AT HIGH ELEVATIONS IN WEST-VIRGINIA. (TRIMBLE 1963)	6A-61-A
ACID	DEVELOPMENT OF BIOLOGICAL INDICES TO POLLUTION LEVELS IN STREAMS AFFECTED BY ACID MINE DRAINAGE AND OIL FIELD BRINE WASTES. (DAMBACH AND OLIVE 1969)	8C-3
ACID	MACROINVERTEBRATE COMMUNITY STRUCTURE AS AN INDICATOR OF ACID MINE POLLUTION. (DILLS AND ROGERS 1974)	8C-4-A

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SIGNIFICANT-WORD

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ADDITIVE
ADEQUACY

ADIRONDACKS

ADJACENT

ADJACENT

ADMINISTRATIVE

ADVANCE

ADVANTAGES
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AFFECTED
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                                   ARTICLE

ACID MINE DRAINAGE CONTROL FEASIBILITY STUDY.   (FERRIS 1973)
OPERATION YELLOWBOYO TREATMENT OF ACID MINE DRAINAGE.   (GIRARD AND KAPLAN 1967)
ACID MINE DRAINAGE RESEARCH POTENTIALITIES.   (HANNA, ET. AL. 1963)
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(SNOW 1938)
SYMPOSIUM ON ACID MINE DRAINAGE RESEARCH.   (MELLON INSTITUTE 1965)
PROGRESS IN CONTROLLING ACID MINE WATERO A LITERATURE REVIEW.   (LORENZ 1962)
LITERATURE PERTAINING TO FORMATION OF ACID MINE WASTES AND THEIR EFFECT ON THE CHEMIS
TRY AND FAUNA OF STREAMS.   (PARSONS 1957)
CHEMICAL, MINERALOGICAL AND PHYSICAL PROPERTIES OF EASTERN KENTUCKY*S ACID-FORMING CO
AL SPOIL MATERIALS.   (BARNHISEL AND MASSEY 1969)
RECLAMATION OF ACIDIC COAL MINE SPOIL WITH FLY ASH.   (ADAMS, ET. AL. 1971)
ACIDITY AND PLANT AVAILABLE PHOSPHORUS IN THE STRATA OVERLYING COAL SEAMS.
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EXCHANGEABLE ACIDITY IN UNBURNT COLLIERY SPOIL.   (CHADWICK, ET. AL. 1969)
OVERBURDEN AND BANK ACIDITY OF EASTERN KENTUCKY STRIP MINES.   (MAY AND BERG 1967)
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S OF PLANT LIGNINS AND SOIL HUMIC ACIDS.   (WILDUNG, ET. AL. 1968)
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SURVIVAL AND ACTIVITY OF SEWAGE MICROORGANISMS IN ACID MINE WATER.
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EFFECT OF OVERHEAD IRRIGATION AND FERTILIZING ON THE CELLULOLYTIC ACTIVITY IN, AND YI
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   (BLAZER AND WARD 1958)
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(MCKEE, ET. AL. 1964)
FERTILIZATION PRACTICES AND SPECIES ADAPTATION FOR STEEP ROAD CUTS IN VIRGINIA.
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RESTORATION TO AGRICULTURE OF LAND WORKED FOR IRONSTONE AND LEVELLED WITHOUT THE ADDI
TION OF TOPSOIL.   (BLOOD, ET. AL. 1961)
MATCH ADDITIVE TO SOIL TYPE FOR BEST STABILIZATION.   (WEIGLE AND WILLIAMS 1968)
ADEQUACY OF THE COAL RESOURCE DATA, FORT-UNION REGION, EASTERN MONTANA.
(MATSON 1975)
SMALL MAMMALS IN A MINE WASTE SITUATION IN THE CENTRAL ADIRONDACKS, NEW-YORKO A CASE
OF OPPORTUNISM BY PEROMYSCUS MANICULATUS.   (KIRKLAND 1976)
SEEDING RESPONSE AND SOIL CHARACTERISTICS ON ADJACENT SAGEBRUSH AND DESERT MOLLY SOIL
S.   (COOK 1961)
AN ECOLOGICAL SURVEY OF AN ARTIFICIALLY BARED AREA AND ADJACENT TERRITORY WITH SPECIA
L REFERENCE TO THE HIGHER INVERTEBRATES.   (COSTLEY 1936)
SURFACE MINE REHABILITATIONO REPORT OF COOPERATIVE ADMINISTRATIVE STUDY TO REHABILITA
TE PHOSPHATE STRIP MINE SITES.   (US FOREST SERVICE 1971)
CHARACTERIZATION OF COAL OVERBURDEN MATERIALS AND MINE SOILS IN ADVANCE OF SURFACE MI
NING.   (GRUBE, ET. AL. 1973)
ADVANTAGES OF RECLAMATIONO AGRICULTURAL CROPS.   (GRANDT 1967)
ACTIVITY OF MICROORGANISMS IN ACID MINE WATER ON AEROBIC HETEROTROPHS OF A NORMAL STR
EAM.   (TUTTLE, ET. AL. 1968)
A QUANTITATIVE STUDY OF THE BOTTOM FAUNA IN SOME UTAH STREAMS VARIOUSLY AFFECTED BY E
ROSION.   (MOFFET 1936)
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AFFECTED	AMOUNTS OF BIG-SAGEBRUSH IN PLANT COMMUNITIES NEAR TENSLEEP, WYOMING, AS AFFECTED BY GRAZING TREATMENT. (COOPER 1953)	4C-3
AFFECTED	SEED GERMINATION AS AFFECTED BY MOISTURE AND SALINITY. (AYERS 1952)	4E-6-A
AFFECTED	WATER INTAKE AS AFFECTED BY SOIL AND VEGETATION ON CERTAIN WESTERN SOUTH-DAKOTA RANGE LANDS. (RAUZI AND KUHLMAN 1961)	4E-63
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AFFECTED	AGRICULTURE AND LAND USE AS AFFECTED BY STRIPMINING OF COAL IN EASTERN OHIO. (MOORE AND HEADINGTON 1940)	7B-23
AFFECTED	DEVELOPMENT OF BIOLOGICAL INDICES TO POLLUTION LEVELS IN STREAMS AFFECTED BY ACID MIN E DRAINAGE AND OIL FIELD BRINE WASTES. (DAMBACH AND OLIVE 1969)	8C-3
AFFECTED	RESTORATION OF AREAS AFFECTED BY COAL MINING. (CONTAKOS 1962)	8G-5
AFFORESTATION	THE SUITABILITY OF CLAY-SLATE SPOIL MOUNDS FOR AFFORESTATION. (BERGE 1970)	2A-7
AFFORESTATION	AFFORESTATION OF COLLIERY SPOIL HEAPS. (LAND AGENTS' SOCIETY 1951)	4A-81-A
AFFORESTATION	CONTAINER-GROWN SEEDLINGS SHOWS POTENTIAL FOR AFFORESTATION OF PENNSYLVANIA COAL MINE SPOILS. (DAVIDSON AND SOWA 1973)	8D-21-A
AFFORESTED	SUCCESSION OF SOIL FAUNA IN AFFORESTED SPOIL BANKS OF THE BROWN-COAL MINING DISTRICT OF COLOGNE. (NEUMANN 1971)	2B-22-A
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AGE	SOME SOIL AGE RANGE VEGETATION RELATIONSHIPS. (WHITE 1971)	2C-28
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AGING	WATER POLLUTION STUDIES IN ACID STRIP MINED LAKESO CHANGES IN WATER QUALITY AND COMMU NITY STRUCTURE ASSOCIATED WITH AGING. (CAMPBELL, ET. AL. 1965)	3C-12
AGRICULTURAL	THE EFFECTS OF OPENCAST COAL MINING ON AGRICULTURAL LAND. (DOUGALL 1950)	2A-29-A
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YIELD	MULE DEER NUMBERS AND SHRUB YIELD UTILIZATION ON WINTER RANGE. (ANDERSON, ET. AL. 1972)	5E-2-A
YIELDS	EFFECT OF OVERHEAD IRRIGATION AND FERTILIZING ON THE CELLULOLYTIC ACTIVITY IN, AND YIELDS ON, A SPOIL BANK RESULTING FROM BROWN COAL MINING. (WERNER 1966)	8B-55-A
YORKSHIRE	GRASSLANDS IN THE RESTORATION OF OPENCAST COAL SITES IN YORKSHIRE. (BROOKS AND BATES 1960)	4A-22-A
YORKSHIRE	FIELD TRIALS ON COLLIERY SPOIL IN WEST RIDING OF YORKSHIRE. (COOPER 1970)	6C-20-A
ZERO	A QUARTER TO ZERO, SURFACE MINING AND WATER SUPPLIES. (AGNEW 1966)	3D-1
ZINC	COPPER, NICKEL, AND ZINC RELEASED FROM ACID MINE SPOIL MATERIALS OF EASTERN KENTUCKY. (MASSEY AND BARNHISEL 1972)	2A-49-A
ZN	PH AND SOLUBLE CU, NI, AND ZN IN EASTERN KENTUCKY COAL MINE SPOIL MATERIALS. (MASSEY 1972)	2A-48-A
ZOOBENTHOS	RIFFLE ZOOBENTHOS IN STREAMS RECEIVING ACID MINE DRAINAGE. (KORYAK, ET. AL. 1972)	3C-37
ZOOPLANKTON	ZOOPLANKTON PRODUCTION IN A SERIES OF STRIP MINE LAKES. (GEILING 1970)	3C-28